Engineering Biology SPARK Awards

Engineering Biology SPARK Awards

Funded UK academic institutions or RTOs to deliver engineering biology projects that help UK SMEs tackle challenges or progress towards developing new products, processes, or services.

Projects started:
1 Sep 2025

Projects finished:
28 Feb 2026

Projects:
15 projects

30 partners

Project size:
£15,000

Innovate UK

Showcase 1
SPARK Awards

Project Name	Speakers
Harnessing Cellulose-Producing Microbes to Boost Drought Resilience in Crops	Anna Alessi Ross Mulhall
High-Yield Expression of Gluten-Detoxifying Enzymes in Pichia pastoris for Commercial Gluten-Free Food Production	Dariusz Abramczyk Andreas Andreou
Techno-Economic Analysis of Fermentation-derived Ingredient to improve Plant-Based Meat Alternatives	Oliver Konzock
Unlocking value from waste: identifying brewers' spent grain-specific hydrolytic enzymes and their potential for scalable manufacturing	Esther Karunakaran
Immune stealthed CAR T-cells from iPSCs for allogeneic transplantation: Engineering Next-Generation Cancer Immunotherapy	Saqlain Suleman Adam Sidaway
Engineering tailored biotherapeutics to target vaginal pathogens.	Conor Feehily
AI-Driven Process Analytical Technology for Real-Time Monitoring of iPSC Aggregate Growth in Bioreactors	Michele Darrow Stuart Naylor

UKRI Innovate UK

AgriFood

Harnessing Cellulose-Producing Microbes to Boost Drought Resilience in Crops

Biorenewables Development Centre & CroBio

Anna Alessi, Ross Mulhall

Innovate UK

CroBio

The Soil Regeneration Company

Innovation in Drought Resilience, Rooted in Biology

Innovate UK Engineering Biology SPARK Award

Harnessing Cellulose-Producing Microbes to Boost Drought Resilience in Crops

18th March 2026

Dr Anna Alessi (BDC)

Dr Ross Mulhall (CroBio)

CroBio

Challenge

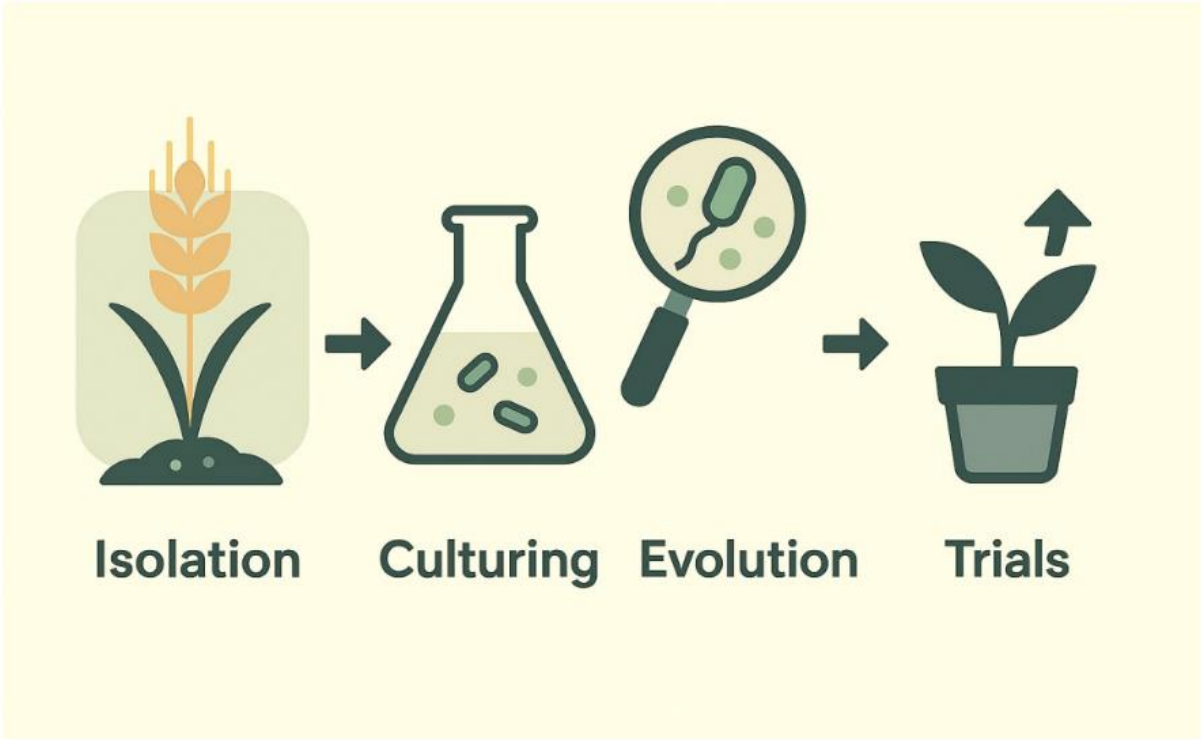
- **Climate change** has accelerated the frequency of severe **drought**, threatened global food security and increased reliance on chemical fertilizers

- CroBio partnered with the open-access RTO Biorenewables Development Centre to **develop an improved, living microbial soil amendment** that helps crops withstand drought conditions

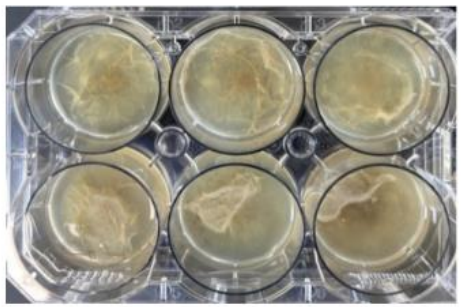
Biorenewables Development Centre

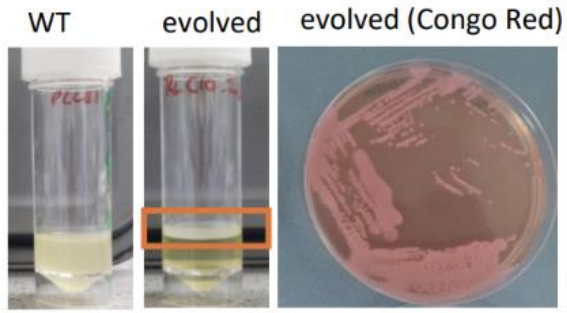
Approach & Innovation

- **Phase 1: Strain Selection and strain development**
- **Phase 2: Scaled Production & Controlled Trials**

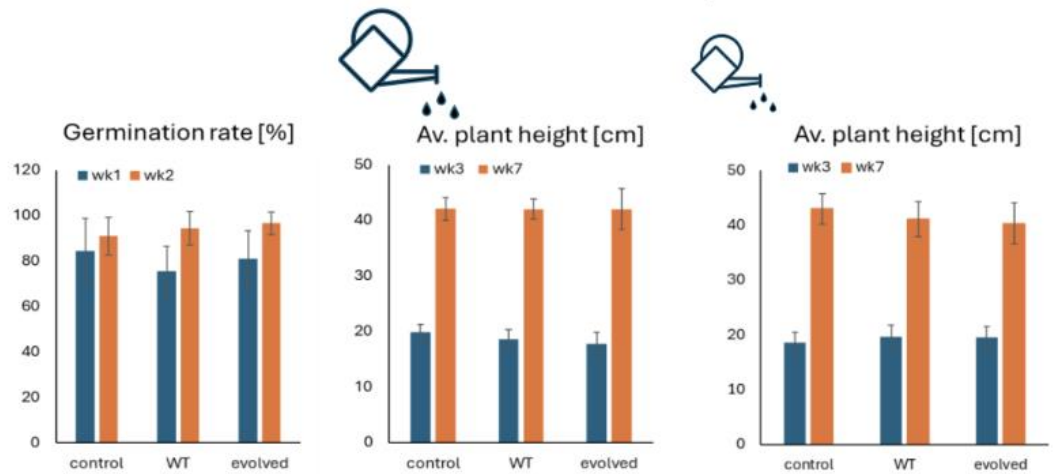


Achievements & Next steps





Phase 1: Strain Selection & Development



Phase 2: Scaled Production & Controlled Trials

Next steps

- further strain development, field trials & large-scale fermentation (part of the IUK FIP project)
- multi-crop expansion
- long-term soil health monitoring

Thank you

Innovate UK

Biorenewables Development Centre

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CroBio

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CroBio, 19f19 Mereside No. 21, Alderley Park, Macclesfield, Cheshire, England, SK10 4TG, UK

AgriFood

High-Yield Expression of Gluten-Detoxifying Enzymes in Pichia pastoris for Commercial Gluten-Free Food Production

University of Edinburgh & Prozymi Biolabs

Dariusz Abramczyk, Andreas Andreou

Innovate UK

High-Yield Expression of Gluten-Detoxifying Enzymes in *Pichia pastoris*

Prozymi Biolabs

THE UNIVERSITY OF EDINBURGH

WP1 **Strain Construction**

Modular promoter-enzyme library in *Pichia pastoris* using methanol-free constitutive promoters

WP2 **Chaperone Co-expression**

PDI and KAR2/BiP chaperone system under bidirectional promoter for enhanced protein secretion

WP3 **Expression Optimisation**

Systematic screening and fermentation scale-up targeting commercial yields

By the Numbers

4 Gluten-detoxifying enzymes (E43, B77, B70, GluZymN1)

5 Methanol-free constitutive promoters tested

20 Promoter-enzyme constructs assembled and verified

2 Host strain backgrounds (wild-type + PDI-engineered)

Key Results

Expression Platform

Built a modular library of 20 promoter-enzyme constructs across 4 proteases and 5 promoters. All constructs sequence-verified; standardised fermentation protocol for secretion recombinant proteins was developed and shared between partners.

Reusable modular toolkit

Lead Enzyme: B77

B77 showed the clearest secreted protein signal on SDS-PAGE at 28 kDa under both glucose and glycerol conditions. Selected for downstream purification optimisation.

E43 protein sequence was optimized to reduce potential toxicity or misfolding.

B77 advancing to scale-up

Chaperone System

Novel low-copy plasmid carrying KAR2 and PDI under a bidirectional promoter. Overcame *E. coli* toxicity from high-copy leakage. Sequence-verified and ready for *Pichia* integration.

Expected to improve recombinant protein folding, stability and reduce ER stress.

Stable construct validation

What Comes Next

Prozymi Biolabs | University of Edinburgh, Barlow Lab

Near-Term Priorities

- Integrate KAR2/PDI chaperone cassette into *Pichia* production strains and benchmark against non-chaperone controls
- Optimise B77 purification to resolve protein loss during downstream processing
- Validate redesigned E43 variant (cryptic signal removed) via Western blot and activity assays

Strategic Goals

- Screen alternative promoters and fermentation conditions for weaker-expressing enzymes (B70, GluZymN1)
- Scale fermentation towards commercial target yields (>5 g/L) using the modular strain toolkit
- Pursue follow-on funding for application testing in gluten-free food manufacturing

Both partners are committed to moving this technology toward a commercially viable gluten-detoxifying enzyme system for the food industry.

Thank you!

AgriFood

Techno-Economic Analysis of Fermentation-derived Ingredient to improve Plant-Based Meat Alternatives

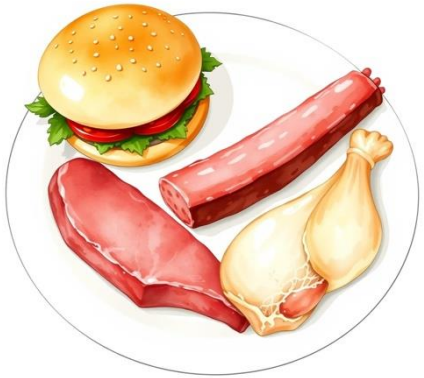
Imperial College of Science, Technology and Medicine & Burford White trading as Shocken Foods

Oliver Konzock

Innovate UK

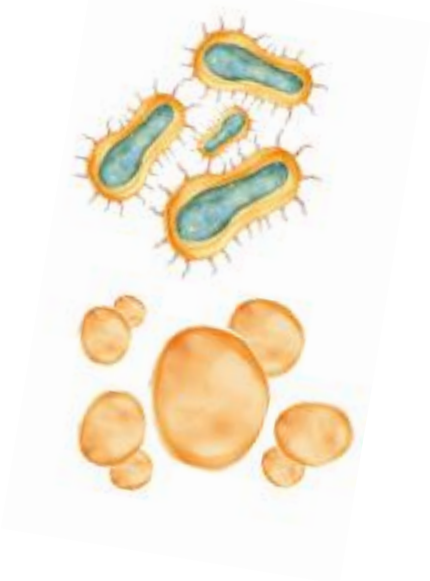
The Challenge

Our food system has a **huge environmental** footprint



Plant-based alternatives have **limitations**

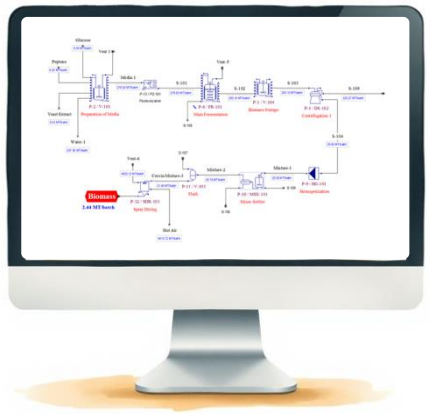
Microbial biomass can **improve products**



What's the price?

shocken FOODS

Our plan



WP1: TEA Model creation

WP2: Data Collection

WP3: Model Simulation and Results

IMPERIAL

Result and what's next

£6.12 per kg

Main cost drivers

Feedstock (glucose)

energy

National Alternative Protein Innovation Centre (NAPIC)

shocken FOODS

Testing of our biomass in real products to test mechanical properties

Energy and low carbon fuels

Unlocking value from waste: identifying brewers' spent grain-specific hydrolytic enzymes and their potential for scalable manufacturing

University of Sheffield & Future Greens

UKRI Innovate UK

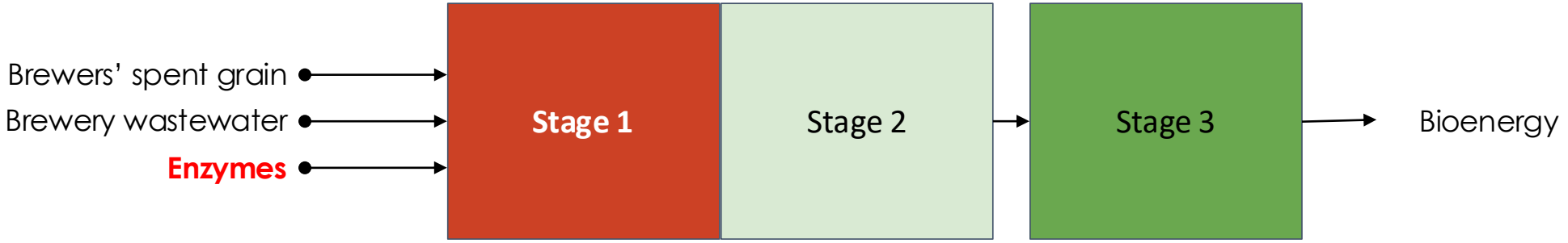
Unlocking value from waste: identifying brewers' spent grain-specific hydrolytic enzymes and their potential for scalable manufacturing

Esther Karunakaran
University of Sheffield

David Dixon
Future Greens Ltd.

University of Sheffield

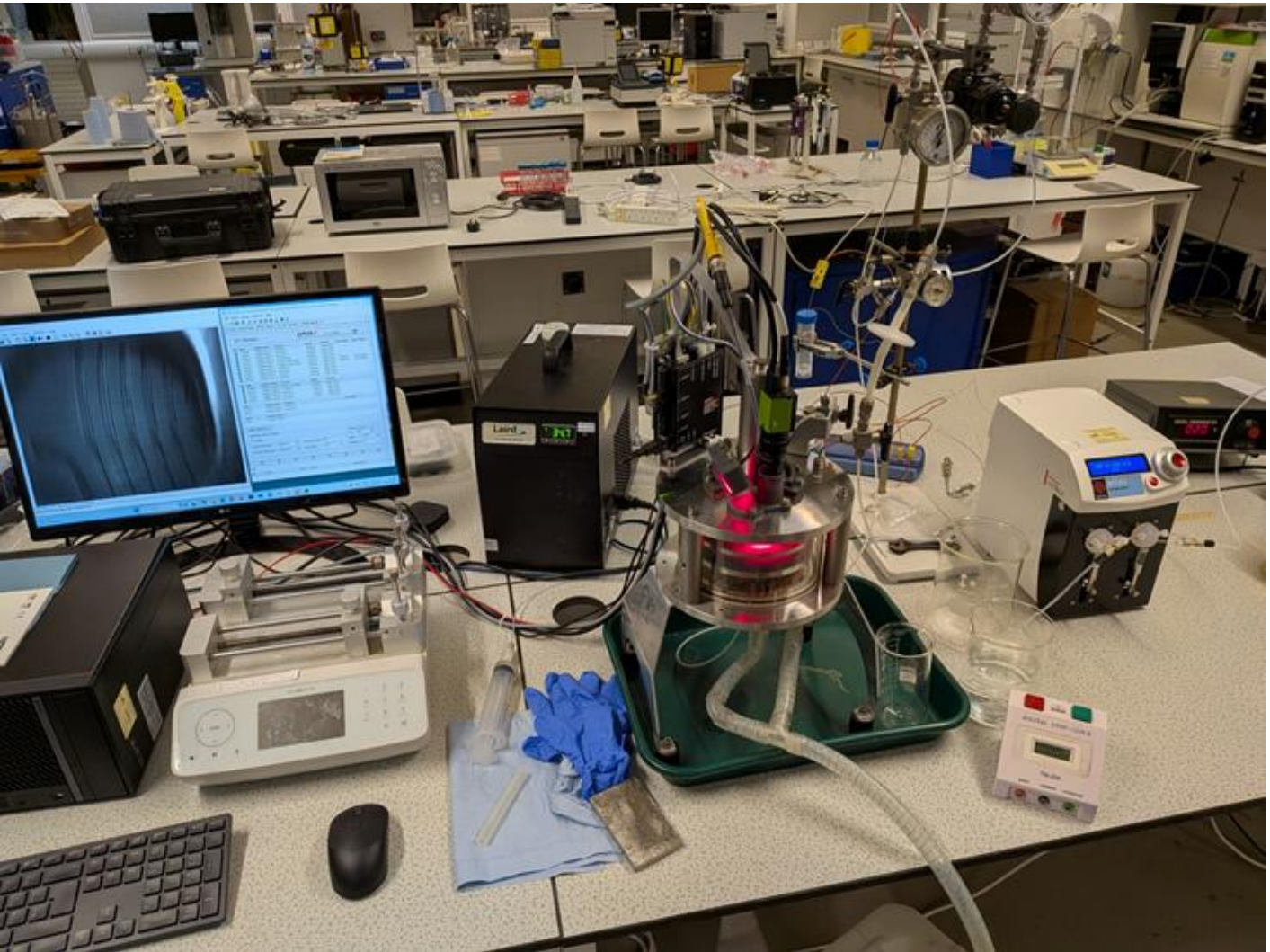
FUTURE GREENS

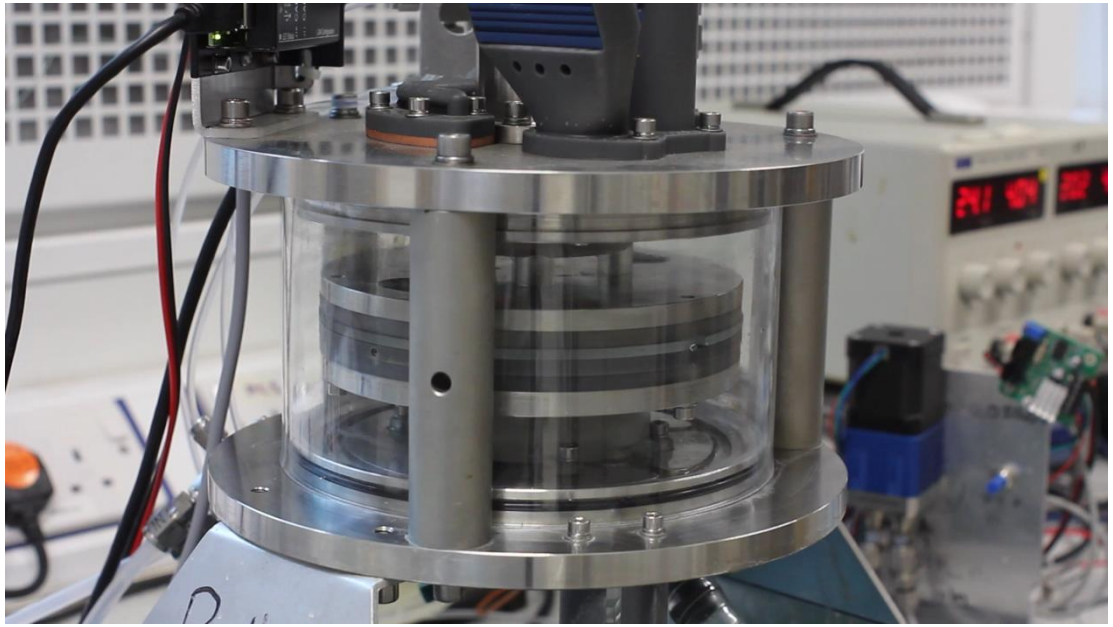


Future Greens Ltd offer an efficient digester with a **6-8x smaller footprint**, **lower cost of maintenance**, and the **unique capability** to process industrial wastewater and (hydrolysed) solid waste in a single reactor.

University of Sheffield

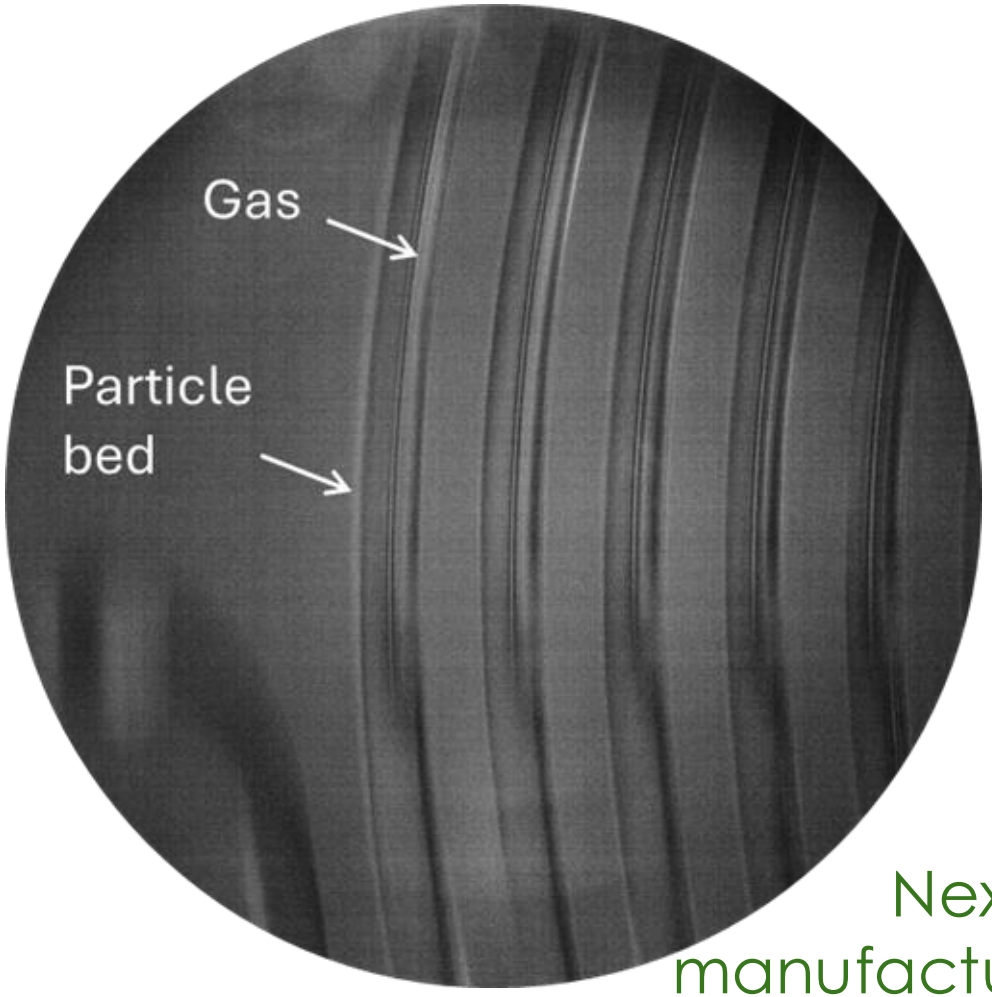
FUTURE GREENS





University of Sheffield

FUTURE GREENS



- WP1_outcome 1: Standardised methods for crude enzyme preparation and evaluation of enzymatic activity.
- WP1_outcome 2: Comparative evaluation of the ability of seven microorganisms to produce hydrolytic enzymes.
- WP1_outcome 3: **Characterisation of a predicted endoglucanase from *Bacillus cereus*.**

- WP2_outcome 1: Comparative evaluation between hydrolytic enzyme production in rotating spiral bioreactor versus shake flasks in four strains
- WP2_outcome 2: **A 6X increase in titre and a 53X increase in volumetric productivity of proteases from the rotating spiral bioreactor.**

Next steps: EngBio approach towards scalable manufacturing of hydrolytic enzymes using the rotating spiral bioreactor for BSG degradation for bioenergy generation

Health

Immune stealthed CAR T-cells from iPSCs for allogeneic transplantation: Engineering next-generation cancer immunotherapy

Anglia Ruskin University & Cambridge RNA Technologies

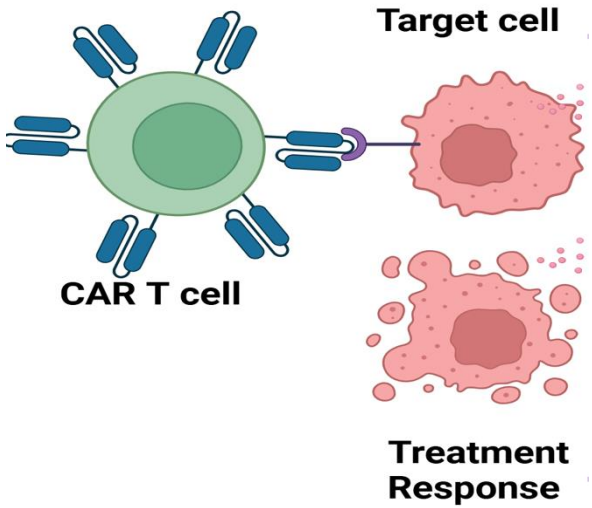
Saqlain Suleman, Adam Sidaway

Innovate UK

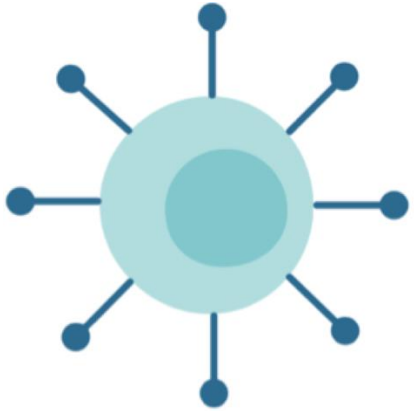
Immune stealthed CAR T-cells from iPSCs for allogeneic transplantation: Engineering Next-Generation Cancer Immunotherapy

Dr Saqlain Suleman (ARU) & Dr Adam Sidaway (Cambridge RNA Technologies)

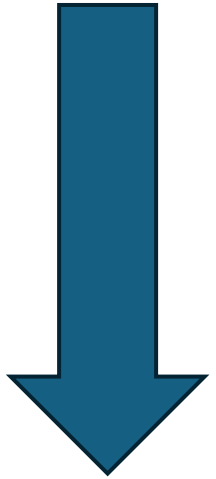
The Challenge



CAR- T cell selective identification and killing of cancer cells



HLA presentation results in graft v host disease and rejection



Efficacy decreases

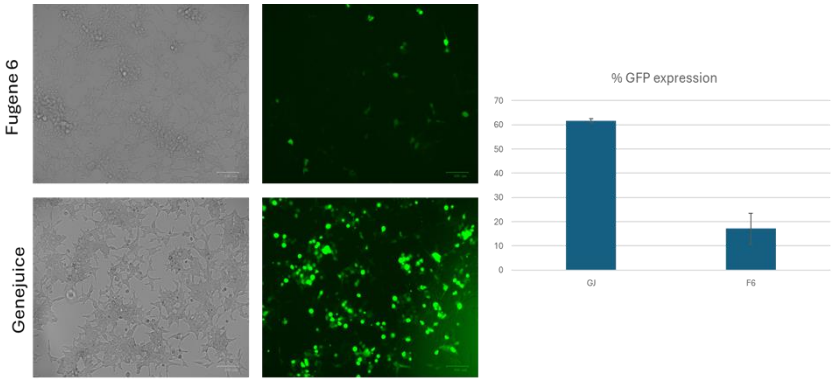
- Conventional solutions use gene editing for total knockout of HLA
- Patients at risk from totally immune silenced cells
- CRT has developed protein level interference mechanism which is reversible with localised inflammation (e.g. viral infection)

a.r.u. | Anglia Ruskin University

Cambridge RNA Technologies

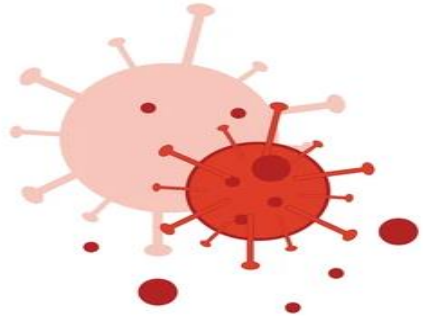
The Approach

1



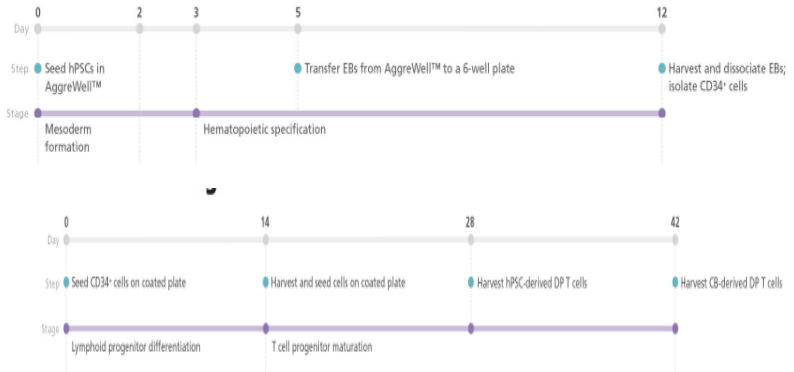
Construct cloning and testing in vitro HEK293T cells

2



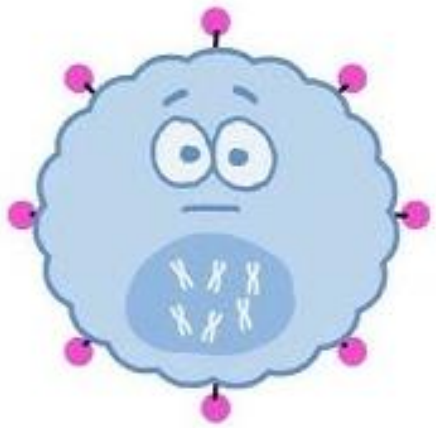
CAR- lentiviral vector production

3



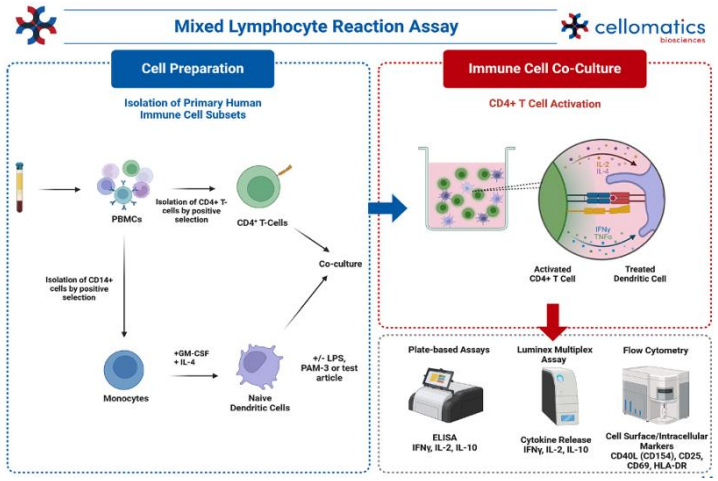
iPSc- T- cell differentiation

4



CAR- T cell generation

5



Mixed lymphocyte killing assays

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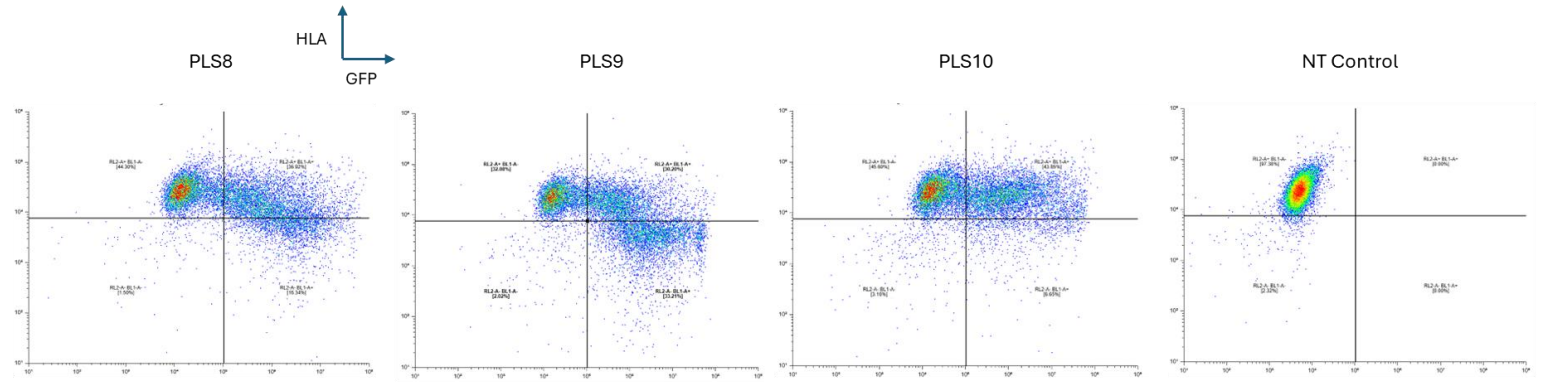
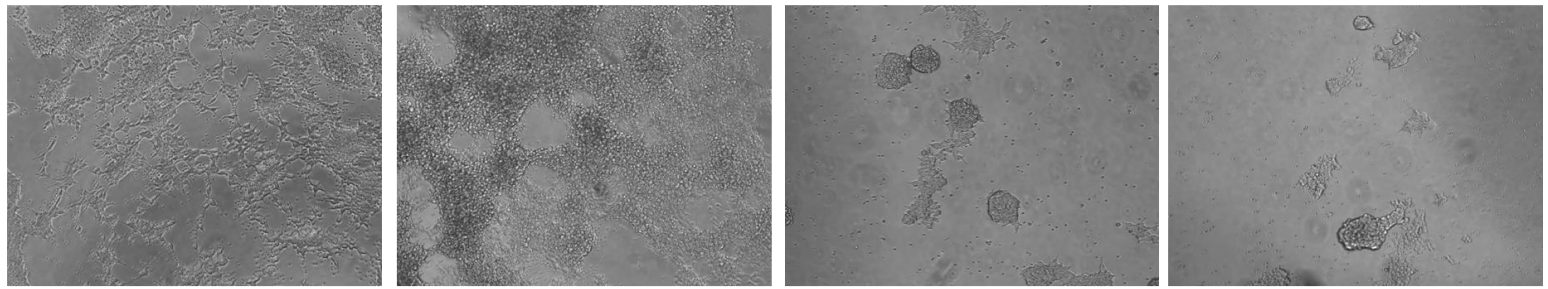
Key achievements and next steps





Mixed lymphocyte assay using HEK293T cells transfected with HLA immune modulation constructs.

- HLA downregulation using all CRT constructs
- Plasmid 9 most successful at interfering with HLA – most protection against allo killing

Next steps

- Expansion of in vitro molecular characterisation
- In vivo assessment
- Industry and academic partners have applied for a UKRI Biomedical catalyst award

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Health

Engineering tailored biotherapeutics to target vaginal pathogens

University of Glasgow & CC Bio

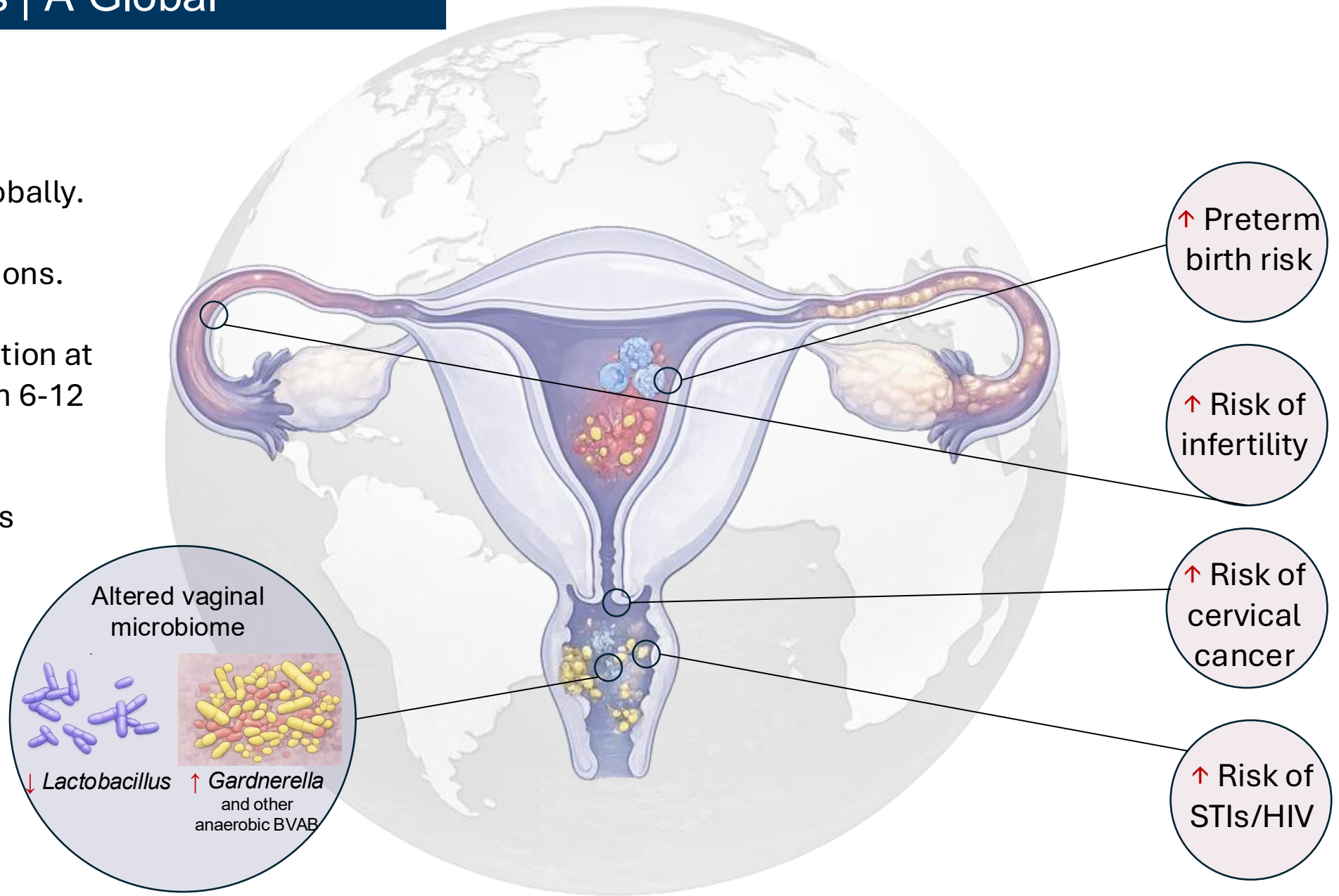
Conor Feehily

UKRI Innovate UK


University of Glasgow
A WORLD TOP 100 UNIVERSITY
Engineering tailored biotherapeutics to target vaginal pathogens.
Dr Conor Feehily
WORLD CHANGING GLASGOW
CC BIO.
GCU Glasgow Caledonian University
UKRI Innovate UK
THE TIMES THE SUNDAY TIMES GOOD UNIVERSITY GUIDE 2024 SCOTTISH UNIVERSITY OF THE YEAR

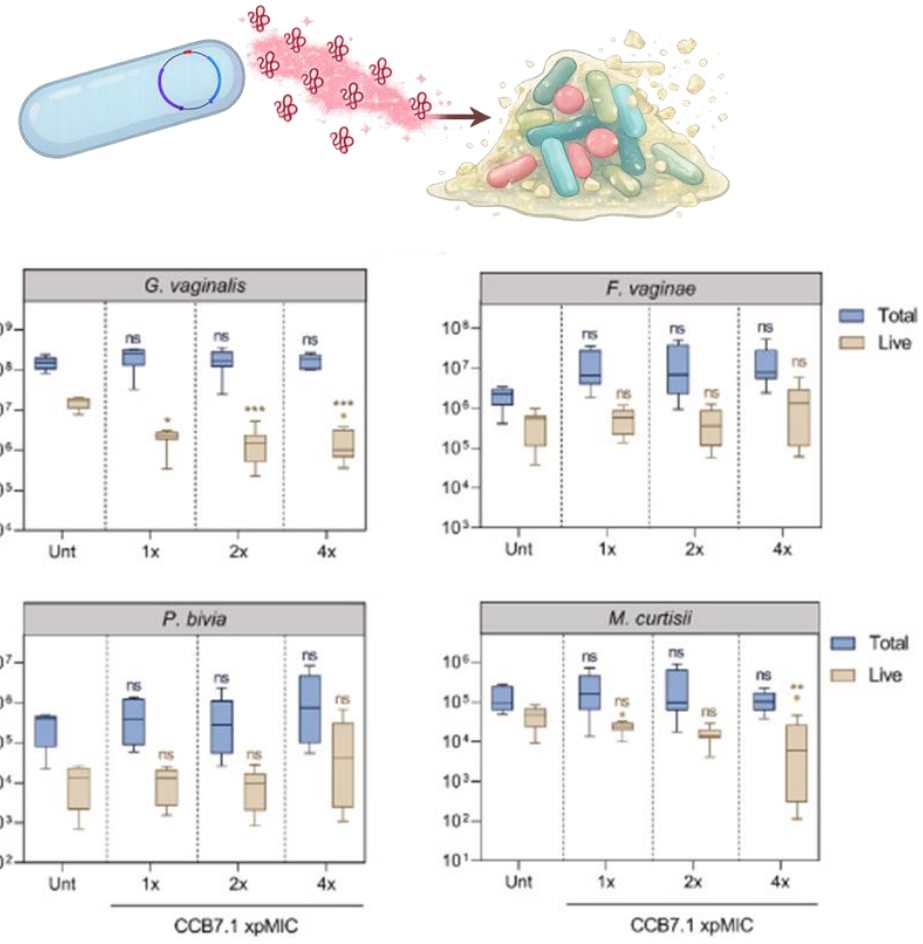
Bacterial vaginosis | A Global

- 20-30% prevalence globally.
- Limited treatment options.
- Recurrence or re-infection at rates above 50% within 6-12 months of treatment.
- Need for new therapies



Anti-*Gardnerella* lysin

CC Bio Ltd identified and developed a lysin that kills BV associated bacteria and biofilms.



Johnston *et al*. 2023. https://doi.org/10.1016/j.bioflm.2022.100101

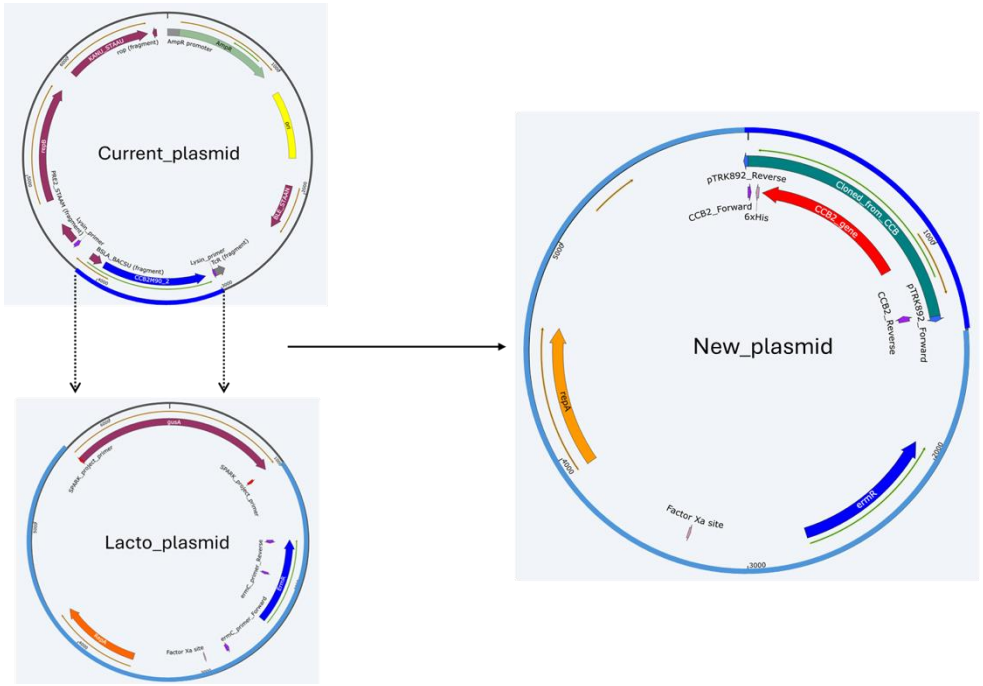
WP Objectives

- WP1: Achieve expression of lysin in *Lactobacillus* strains through plasmid engineering and transformation.
- WP2: Evaluate functional activity of engineered strains against *Gardnerella* isolates.
- WP3: Test activity of engineered strains in a vaginal epithelial model to assess potential for *in situ* function.

Progress and future

- Lysin variants received from GCU.
- Confirmed inhibitory activity of lysin against *G. vaginalis*.

- Sub cloned lysin into a suitable *Lactobacillus* expression vector.



- Ongoing attempts to transform into vaginal *Lactobacillus* species.

What's next

Lab work continues

Exploring potential funding opportunities
- Requires funding of personnel

PhD studentship
Engineering beneficial bacteria to restore vaginal health

Dr Matthew Cummings
Dr David Corcoran
Dr Ryan Kean

Health

AI-Driven Process Analytical Technology for Real-Time Monitoring of iPSC Aggregate Growth in Bioreactors

Rosalind Franklin Institute & Sterling Bio Machines

Michele Darrow, Stuart Naylor

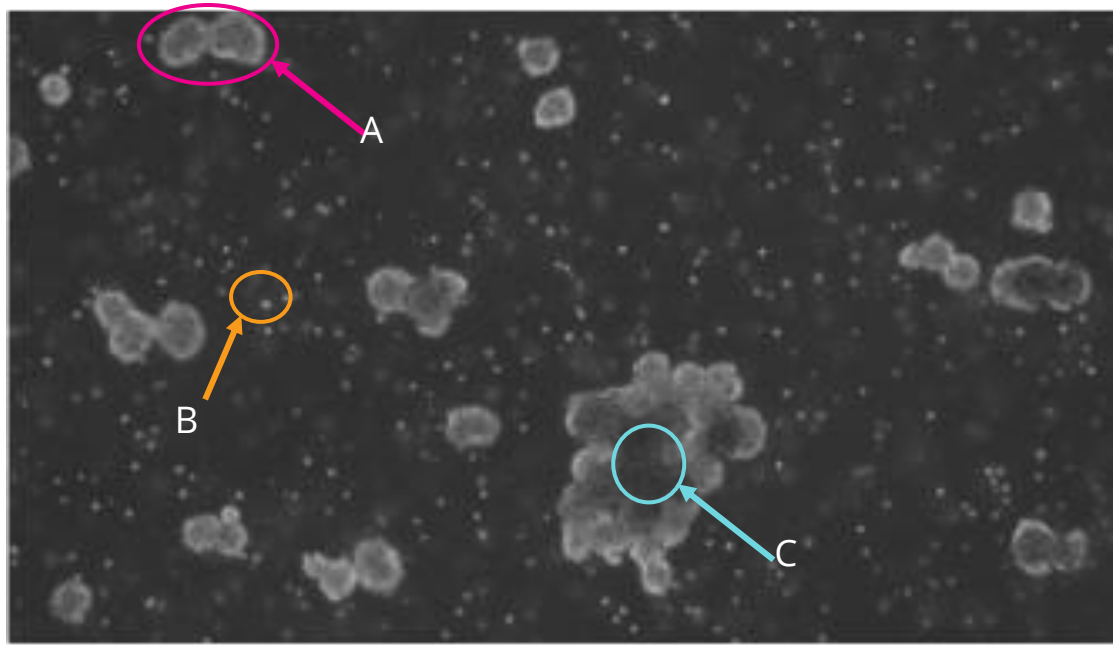
Innovate UK

The Challenge Addressed

The Problem

- **Manual Quality Monitoring:** Operator visually inspect microscopy image
- **Visual Complexity of iPSC Images:** Image contains mixed objects (i.e. single cells, embryo bodies, necrotic debris)
- **Run-to-run variability**
- **Data and annotation scarcity**
- **Goal: Early stage detection** of aggregates forming

What the pipeline must detect



- A = Mature Aggregates (Embryo Body)
- B = Single cell
- C = Necrotic core

Model Approach | Rosalind Franklin Institute

01 Annotation Pipeline

- U-Net model > initial masks
- Size filtering
- CellPose-SAM
- **Boundary mask**
- **Point mask (Single Cells Only):** placing a point at center of object using centroids

02 Model Development

Embryo Bodies model: 2-head U-Net + ConvNeXtV2-base (Segmentation + Boundary mask)

Single Cell model: **Novel** 3-head U-Net + ConvNeXtV2-base (Segmentation + boundary + points mask)

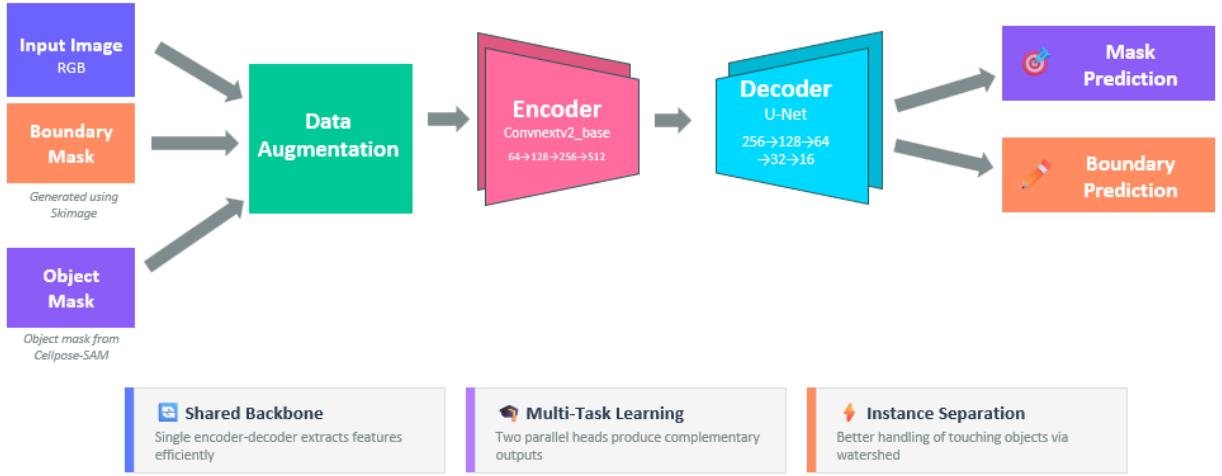
03 Metric Outputs

- Cell count
- Morphological attributes
- Intensity attributes
- **Touching cells: KD-Tree queries pixel boundaries**

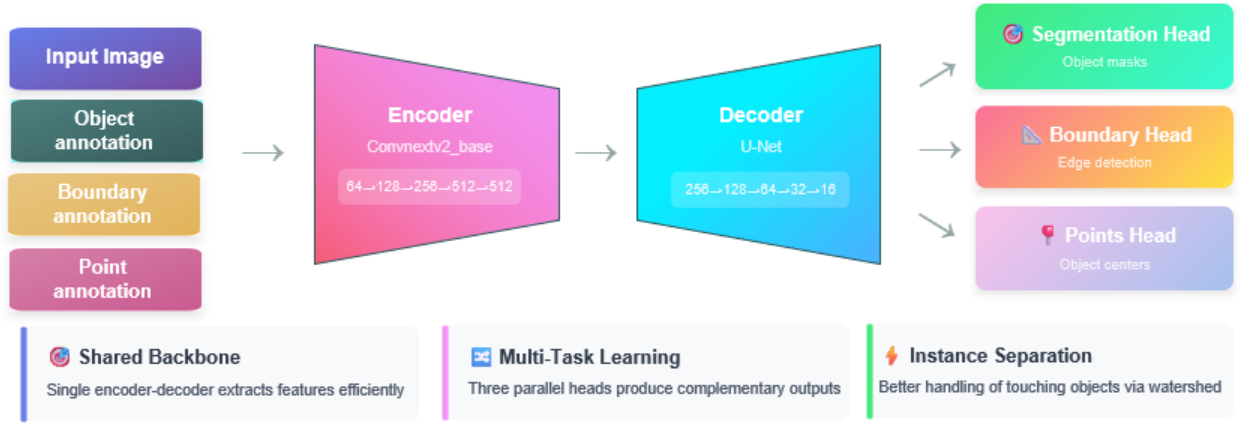
04 Deployment

- Docker containerised apps
- Streamlit interactive GUI
- Flask REST API (batch / single)

2-Head U-Net Architecture

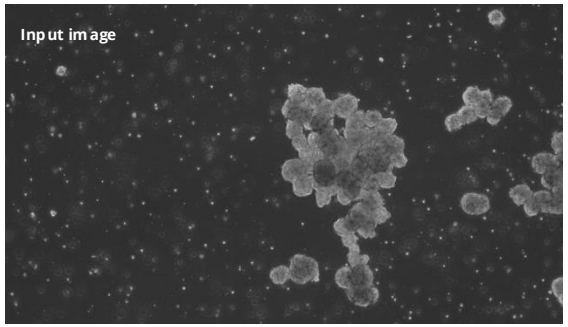


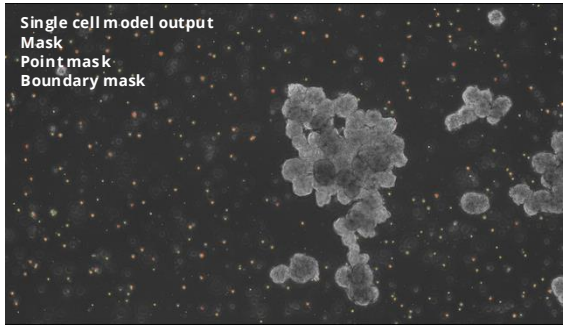
3-Head U-Net Architecture

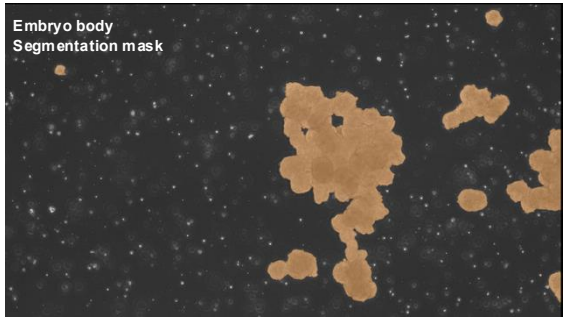


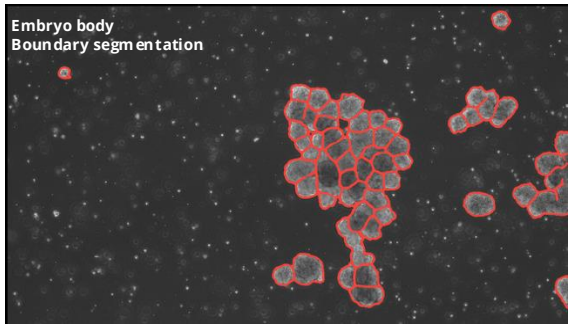
The Rosalind Franklin Institute

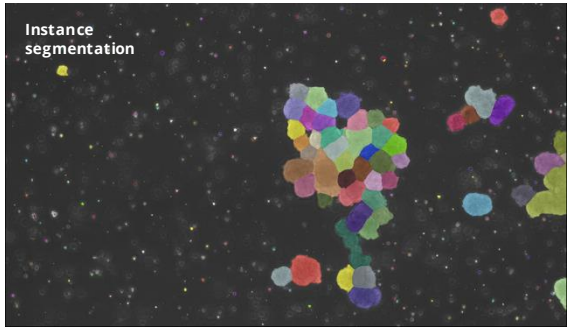
Key Achievements & Outputs

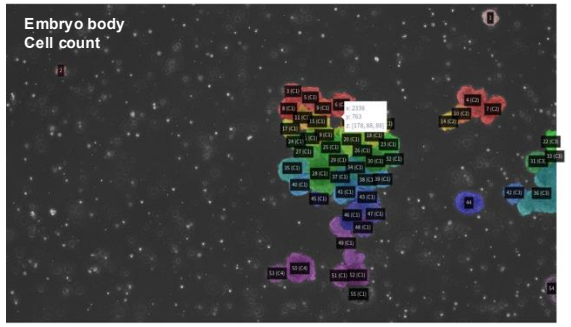






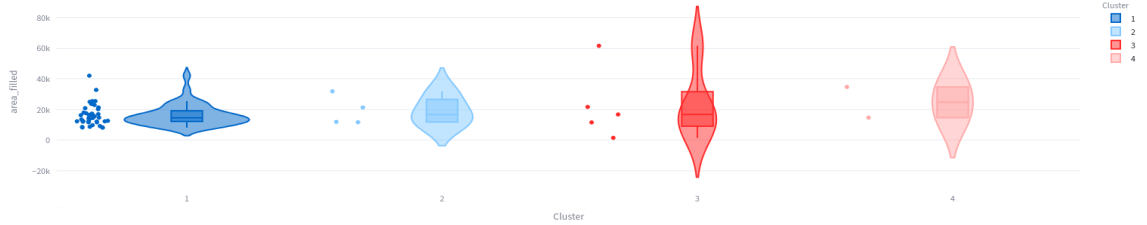






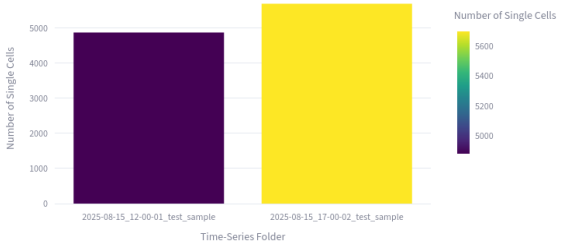
Total Single Cells	Total Touching Single Cells	Total Embryo Bodies	Touching EB Clusters	Total Touching EBs
294	7	55	4	51

Violin Plot: area_filled by Cluster

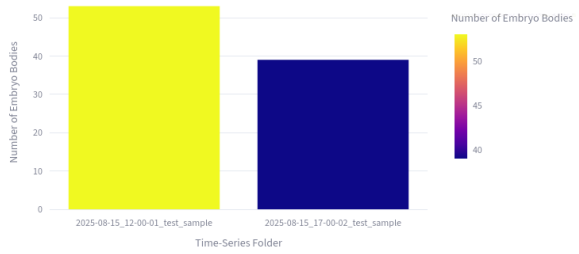


Violin Plot: Diameter by Cluster

Number of Single Cells per Time-Series



Number of Embryo Bodies per Time-Series



The Rosalind Franklin Institute

Room	Project Name	Speakers
1	Harnessing Cellulose-Producing Microbes to Boost Drought Resilience in Crops	Anna Alessi Ross Mulhall
2	High-Yield Expression of Gluten-Detoxifying Enzymes in Pichia pastoris for Commercial Gluten-Free Food Production	Dariusz Abramczyk Andreas Andreou
3	Techno-Economic Analysis of Fermentation-derived Ingredient to improve Plant-Based Meat Alternatives	Oliver Konzock
4	Unlocking value from waste: identifying brewers' spent grain-specific hydrolytic enzymes and their potential for scalable manufacturing	Esther Karunakaran
5	Immune stealthed CAR T-cells from iPSCs for allogeneic transplantation: Engineering Next-Generation Cancer Immunotherapy	Saqlain Suleman Adam Sidaway
6	Engineering tailored biotherapeutics to target vaginal pathogens.	Conor Feehily
7	AI-Driven Process Analytical Technology for Real-Time Monitoring of iPSC Aggregate Growth in Bioreactors	Michele Darrow Stuart Naylor

UKRI Innovate UK

Showcase 2
SPARK Awards

Innovate UK

Project Name	Speakers
High-throughput optimization of carbon mineralization by engineered cyanobacteria: towards carbon negative mineral materials?	Julie Cosmidis
Unlocking High-Performance Microalgae for Sustainable Lutein Manufacturing	Dale Mcclure Evelyn Peters
Accelerating biopolymer innovation: a pilot dataset and model for bio-based polymer solubility prediction	Alexi Lapkin Anna Zhenova
Building a modular genetic toolbox for a new circular economy chassis	Peter Vegh Luke Braidwood
Valorisation of Industrial side-streams for Bioproduction of Rare and vAluable Natural Terpenoids (Carotenoids): Acronym VIBRANT	Donal McGee
BioReWool: Engineering Biological Pathways for Next-Gen Keratin Fibres from Textile Waste	Nimra Nawaz
Metagenomic Discovery of Marine Microbial Enzymes for Thermoset Resin Composite Recycling	David Green Joe Penhaul-Smith

UKRI Innovate UK

Materials and chemicals

High-throughput optimisation of carbon mineralization by engineered cyanobacteria: Towards carbon negative mineral materials

University of Oxford & CyanoCapture

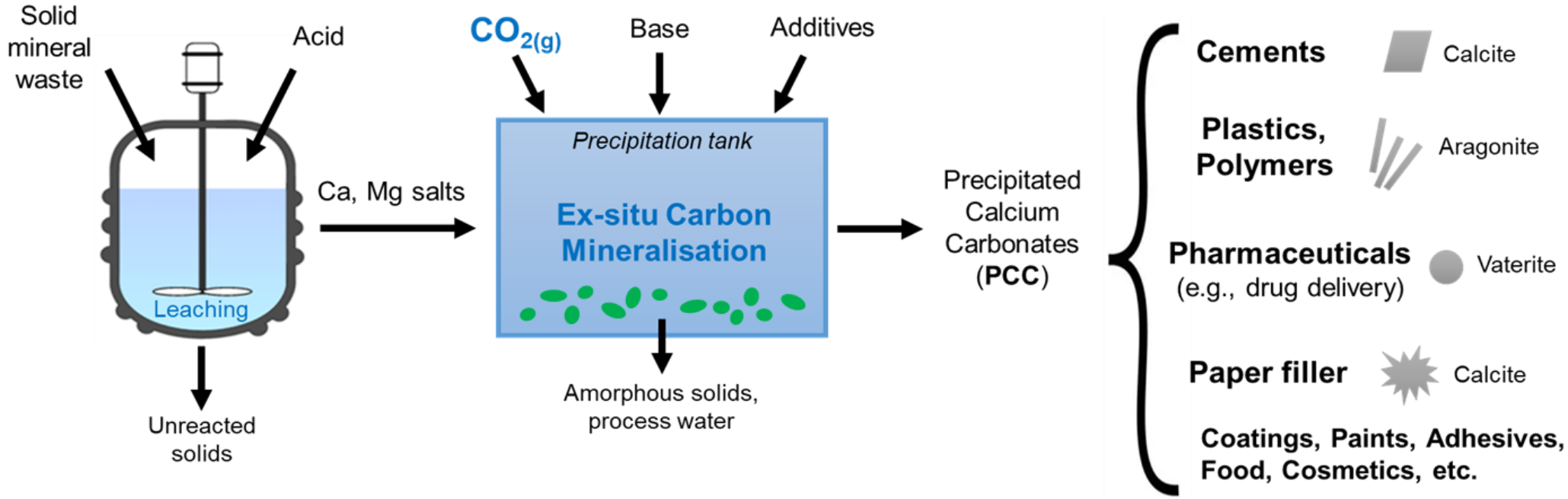
Julie Cosmidis

Innovate UK

High-throughput optimization of carbon mineralization by engineered cyanobacteria: towards carbon negative mineral materials?

Julie Cosmidis, Luca Stigliano, Mohammed Rehmanji, University of Oxford, Dept. of Earth Sciences
Uma Sagaram, CSO, CyanoCapture Ltd.

- CyanoCapture has engineered strains of fast-growing cyanobacteria for photosynthetic biomanufacturing
- **Goal:** Assess the potential for bioprecipitation of calcium carbonates for sustainable mineral manufacturing



CO_2 fixation and carbonate bioprecipitation has the potential to produce carbon-negative mineral particles for different industrial applications

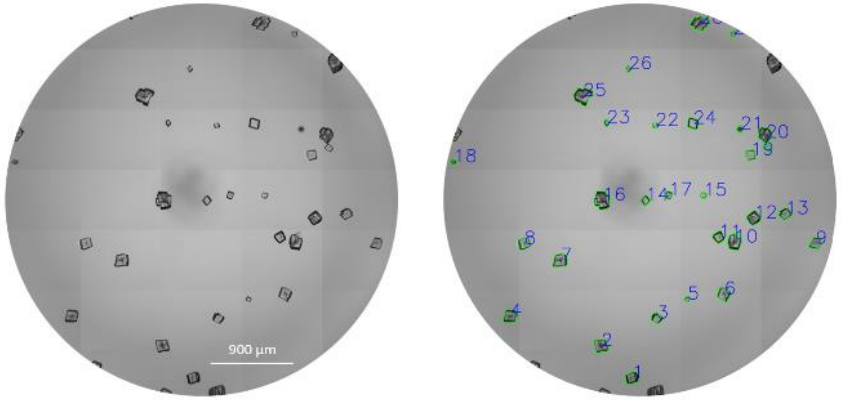
Approach:
High-throughput *in-situ* spectromicroscopy

Biomineralization experiments in 96-well plates

Chemical parameters
- Ca^{2+} and Mg^{2+} concentrations
- Mg/Ca ratio
- $CO_{2(g)}$
- pH, temperature, agitation, additives, etc.

Biological parameters
- 4 strains tested

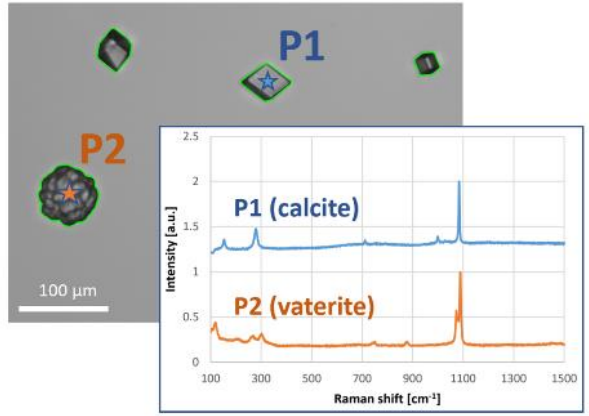
For each well:



	Particle 1	Particle 8	Particle 14	Particle 20	Particle 25	Particle ...
Area	85496	81190.5	37838	137482.5	149601.5	...
Perimeter	1277.9	1192.9	770.5	2051.3	1725.1	...
Eq Diameter	329.9	321.5	219.5	418.4	436.4	...
Aspect Ratio	1.23	1.18	1.09	1.86	1.08	...
Eccentricity	0.58	0.53	0.41	0.84	0.38	...
Elongation	0.18	0.15	0.09	0.46	0.07	...
Circularity	0.66	0.72	0.80	0.41	0.63	...
Solidity	0.98	0.98	0.99	0.77	0.93	...
Extent	0.75	0.75	0.60	0.58	0.64	...
Rectangularity	0.75	0.75	0.60	0.58	0.64	...
Others	...	...	...	...	...	...

Automated Microscopy
- Automated particle detection
- Total particle yield
- Morphometric analysis
- Particle classification

Raman spectroscopy
- Particle composition
- Crystal structure

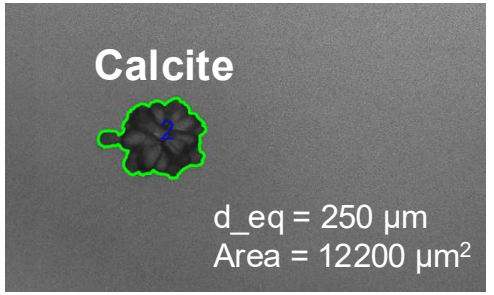


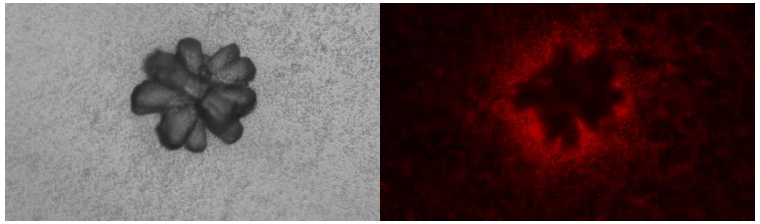
→ Can rapidly build large datasets (100s of independent experiments) testing the effect of several parameters on mineralization intensity and particle properties

Key achievements

M14 (2.45 + 65 mM $CaCl_2$; 1.89 Na_2CO_3 mM; T = 28 °C; non agitated; initial pH = 7.1)

Time-lapse imaging





Experimental outcomes

- Identification of the most efficient strain for bioprecipitation
- Particle yield increase with Ca^{2+} concentrations, but levels >450 mM are toxic to the cells
- CO_2 enrichment accelerates the onset of mineralization
- Mg acts as a strong inhibitor
- Biomineral characterization: calcite crystals with rough textures and complex morphologies

Next steps

- **Improve C removal efficiency:** currently ~12 µg/well → ~120 µgC/L (2-3 orders of magnitude less than abiotic methods)
- **Biomineralization mechanism**
- CyanoCapture will continue to focus on photosynthetic biomanufacturing of high-value molecules

Materials and chemicals

Unlocking High-Performance Microalgae for Sustainable Lutein Manufacturing

Brunel University London & FutureAlgae

Dale Mcclure, Evelyn Peters

UKRI Innovate UK

Brunel University of London

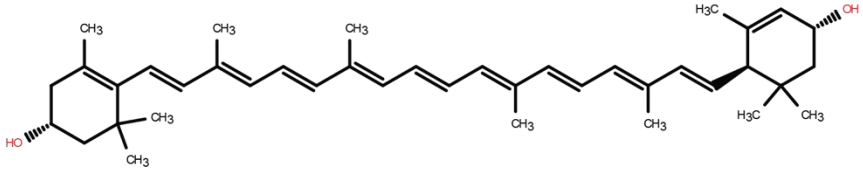
Unlocking High-Performance Microalgae for Sustainable Lutein Manufacturing

Evelyn Peters
evelyn@futurealgae.com

Dr Dale McClure
dale.mcclure@brunel.ac.uk

The Challenge

- Microalgae have large potential for sustainable production of numerous compounds.



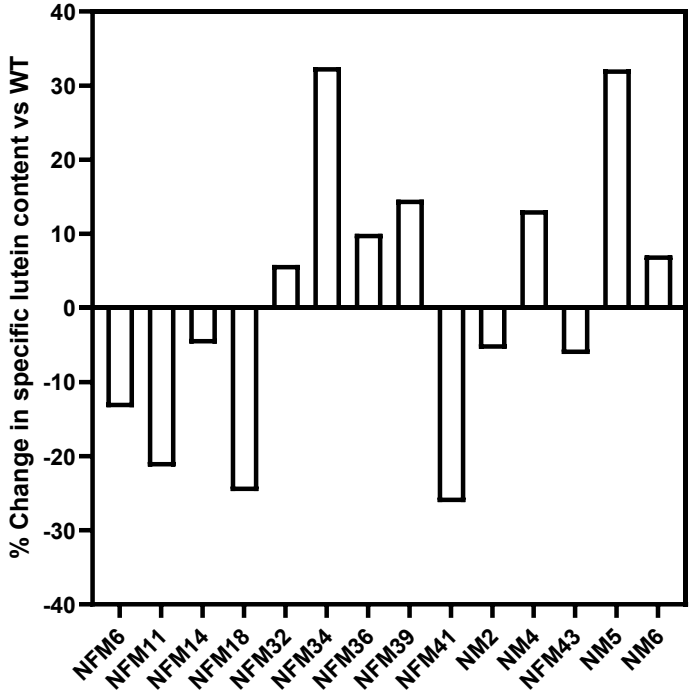
- The major challenge is the high cost of production.

- Access to improved strains can significantly improve the process economics.

Approach and Achievements

- Approach:
  - Screen green algae (10 species) for lutein content.
  - Identify candidates suited for FutureAlgae's production system.
  - Mutagenesis chosen for strain development (clean label).

- Achievements:
  - Mutagenesis and screening protocol developed.
  - Mutant library (> 50) strains generated.
  - **Best strains have ~30% higher lutein concentration than parent**.
  - Biomass generated for downstream testing.



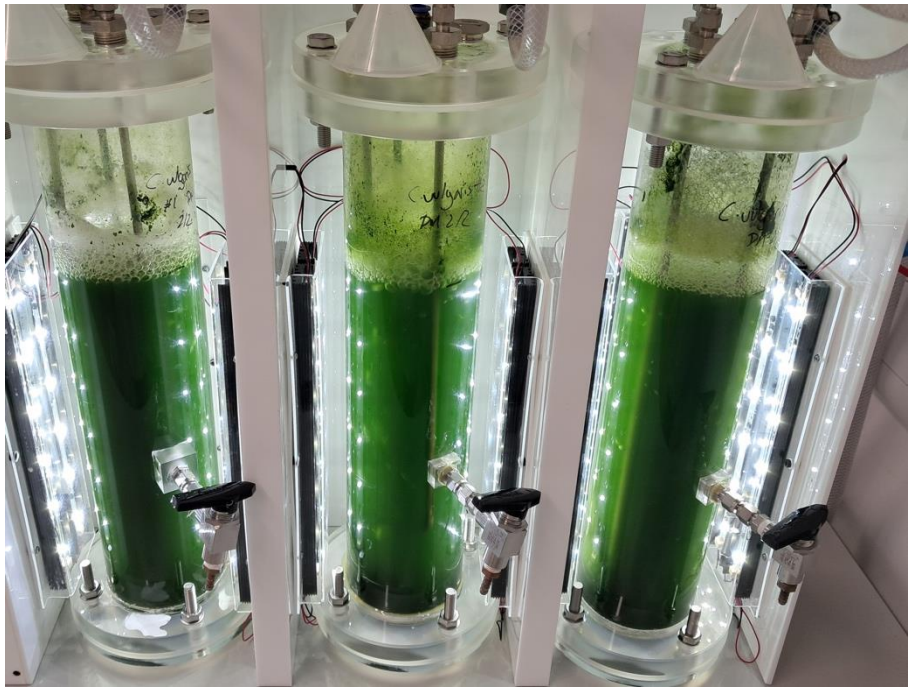
What’s next

- Process development with improved strains – test scalability and performance.

- Evaluate strains under commercially relevant conditions.

- Integrate results with work on extraction and downstream processing.

- Continue collaboration to support scale-up and process development.



Materials and chemicals

Accelerating biopolymer innovation: a pilot dataset and model for bio-based polymer solubility prediction

University of Cambridge & Green Rose Chemistry

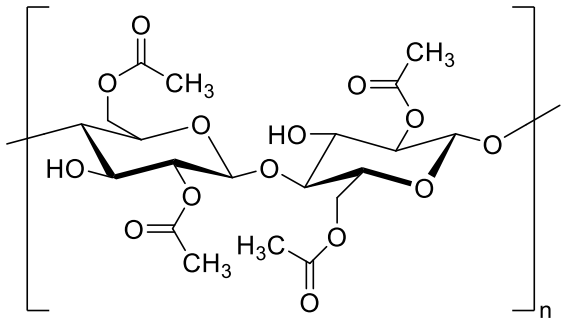
Alexei Lapkin, Anna Zhenova

UKRI Innovate UK

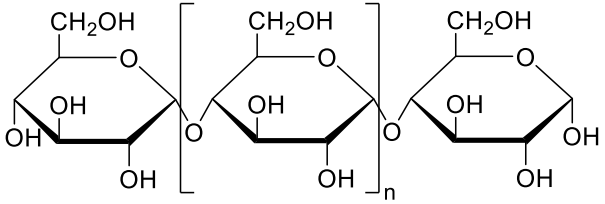
The Challenge Addressed

- Natural polymers are abundant in waste streams and are well suited for a wide range of applications
- Their processability is poorly understood—predicting swelling or dissolution is challenging
- Limited data availability restricts use of ML-based modeling

cellulose



chitosan



Biomedical & Drug Delivery

Personal Care

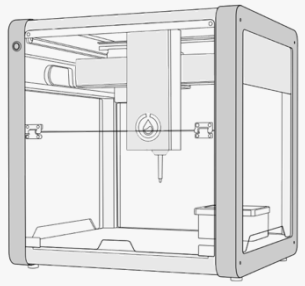
Detergents & Household

Sustainable Packaging

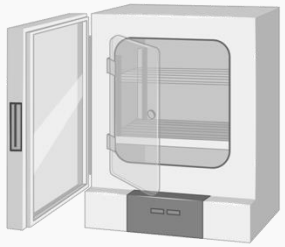
Approach Taken

1) High-Throughput Screening Workflow

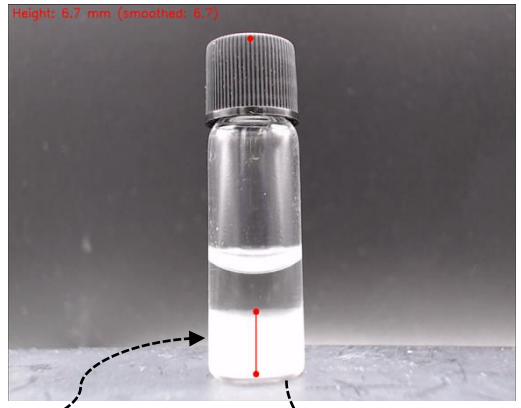
Automated Dispensing
(Powders and Beads)



Dispensing of Solvents
(4, 6, 8 wt/vol%)



Agitation (360 RPM) for 24 hours
(4, 25, 50, 75°C)

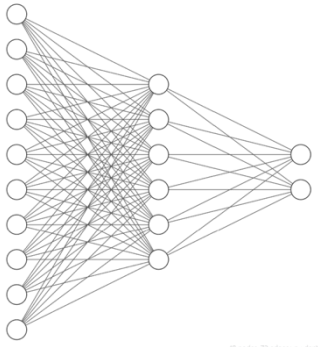


10,000 solubility data points across 50 natural polymers screened with single solvent and reagent-solvent (20% v/v)

2) Data-Driven Modelling and Identifying Swelling Solvents

SOLVENT DESCRIPTORS
(SMILES, HBA/HBD, Mw, dipole moment, polarity, dielectric constant, LogP)

POLYMER DESCRIPTORS
(repeating unit SMILES, HBA/HBD, Mw, pDI, crystallinity, Tg/Tm, charge density, DS/DE/DDA, crosslinks)



"predict which solvents swell" (classification problem)

UNIVERSITY OF CAMBRIDGE

iDMT
Innovation Centre in Digital Molecular Technologies

Key Achievements, and What's Next

	Green Rose Chemistry		University of Cambridge	
Key Achievements	Developed user flow and prototype front-end software for dissolution prediction	Confirmed interest from 5 major potential customers across UK, EU, and US	Established a pipeline of workflow for data and modelling which is useful for upstream natural polymer suppliers	Established a foundational dataset for natural polymer processing behaviours
What's Next	Validate software user interface in tests with industry partners	Understand key customer needs for natural polymer processing to inform future R&D	Potential academic collaboration with upstream natural polymer suppliers to further fundamental investigations	Collaboration with Prof. Jason Hallet (Imperial) on driving sustainability using biopolymers for high performance materials

GREEN ROSE CHEMISTRY

UNIVERSITY OF CAMBRIDGE

iDMT Innovation Centre in Digital Molecular Technologies

Waste recycling

Building a modular genetic toolbox for a new circular economy chassis

University of Edinburgh & MiAlgae

Peter Vegh, Luke Braidwood

UKRI Innovate UK

320 million litres pot ale co-product

Omega-3s

70%

20%

320 million litres pot ale co-product

Low value whisky co-product

10%

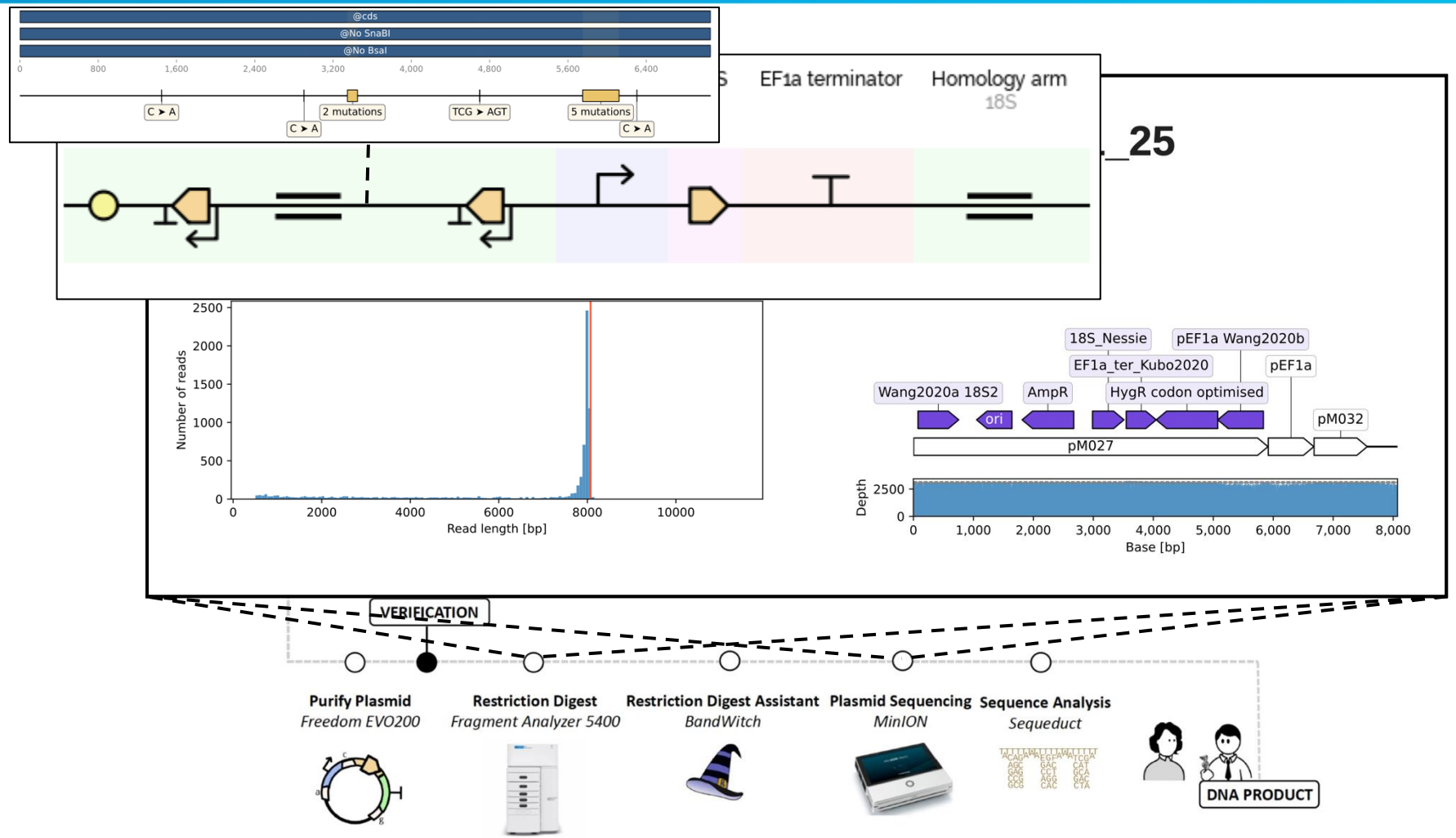
Engineering biology – R&D tool for process optimisation

Challenge – non-model organism with few genetic tools

Needed ability to build a modular library for future work

THE UNIVERSITY of EDINBURGH
Centre for Engineering Biology

EGF's modular DNA assembly workflow



Innovate UK | Business Connect

Edinburgh Genome Foundry

MiAlgae

The Future

Achievements:

- Sequence-validated DNA plasmids
- Toolbox suitable for high-throughput Engineering Biology work
- Species- and gene-agnostic design and assembly workflow
- Opportunity to collaborate thanks to UKRI Innovate UK

Next steps:

- Test genetic components (promoters, reporters) in MiAlgae production strain
- Scope future projects – high-throughput assays using EGF's automated platforms

Collaboration / support opportunities:

- Protein and metabolic engineering – especially on the design/data side
- Support for navigating regulatory pathways with emerging technologies

Waste recycling

Valorisation of Industrial side-streams for Bioproduction of Rare and vAluable Natural Terpenoids (Carotenoids): Acronym VIBRANT

Royal Holloway University of London
& AlgaeCytes

Donal McGee & Paul Frasier

UKRI Innovate UK

Valorisation of Industrial Side-streams for Bioproduction of RAre and Valuable Natural Terpenoids "VIBRANT"

Dr Donal Mcgee, Dr John Macdonald & Dr Valeria Candelo

Prof Paul D. Fraser (p.fraser@rhul.ac.uk), Dr Genny Enfissi, Dr Laura Perez-Fons, Dr Marilise Nogueira,Dr Margit Drapal & Dr Harriet Berry

Aims & Objectives: VIBRANT project directed towards unlock the untapped potential of EPA production side-stream.

- Used advanced metabolite profiling to identify high-value compounds within the material.
- Selectively enrich beta-carotene.
- Evaluate biocatalytic transformation using engineered enzymes.
- Assess the commercial and market opportunities for these compounds.

Innovate UK

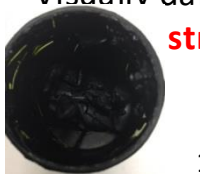
Engineering Biology SPARK Award winners

#EngBioInnovationNetwork

Alga diversity profiles
Beta carotene & zeaxanthin (to be confirmed)

VIBRANT project outcomes

Starting material: Valorisation of algal side stream
Visuallv dark green tar-like substance with
strong fish-like odour !!!



Deliverable 1 & 2

Resuspended in (i) Hexane, (ii) ethyl acetate, & (iii) chloroform
Comments – identify beta-carotene & chlorophyll degradation products but at scale column blocked
Output per gram tar - 1mg beta carotene

Deliverable 2

1. liquid:liquid partition
(i) Ethyl acetate, (ii) Chloroform & (iii) hexane –partitioned against methanol and water – overnight.
Partition only with chloroform but requires water wash.
Both Hexane and ethyl acetate require 10-fold ration of water to see a partition NOT workable.

2. Loaded directly onto TLC –messy

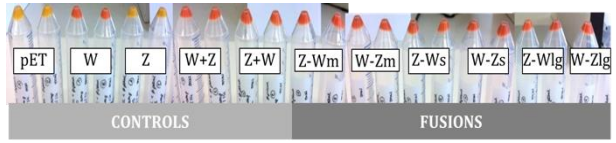
Deliverable 1

1. Washed Polar – profiled by LC/MS and GC-MS –lipids & potential sterols.
2. Non-polar hexane washed fraction profiled by GC/MS – lipids and potentially sterols.

3. Loaded onto alumina column grade III, in Pet-ether 40-60 oC
Pure beta carotene eluted – column blocks with other solvents.
NO ODOUR

Deliverable 3

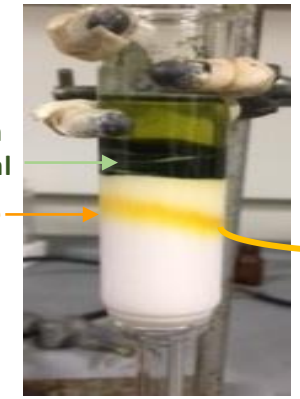
1. Biocatalysis with carotenoid hydroxylase and oxygenase– produced in *E.coli*

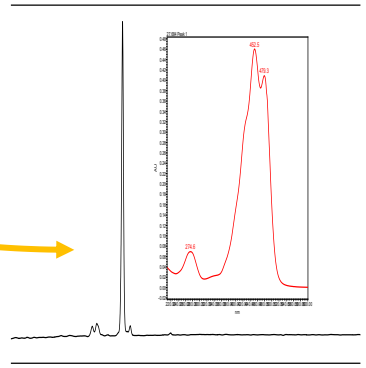


1. Gram quantities of tar mixed with Alumina (grade III) or Silica (1gram /5-gram Al/Si powder and Pet-ether 40-60oC.
2. Stirred overnight – then sedimented results in a green sediment – solvent removed – (can be stored frozen).
3. Solid sediment loaded onto an alumina column
3g sediment to 10g Alumina column in Pet-ether 40-60.
Alumina grade I & II blocks, **grade III works**
Elution in Pet-ether 40-60 works
Elution in Pet-ether 40-60 plus 0.5% Diethyl ether works.
Followed by methanol blocks column
4. Beta carotene conformed by HPLC and TLC
NO ODOUR

Deliverable 2

Sedimented alumina with bound material
Beta carotene





Deliverable 4: Techo-Economic evaluation

- Target chemical reference standard market- £0.5 cost to make 1mg (without labour) retail at £20 per 5mg,
- £100 cost to make 1g (with labour) ca £1500 to £2000 – net profit ca £1000/gr.

Can be sold via NATCOM £

Outcomes

- Creation of a market-ready beta-carotene reference standard.
- Identification of new high-value product opportunities.
- Clear commercial pathway for valorising the AlgaeCytes side-stream
- Strengthened collaboration and readiness for follow-on funding.
- Enhanced UK capability in Engineering Biology and Circular Bioeconomy applications.

Waste recycling

BioReWool: Engineering Biological Pathways for Next-Gen Keratin Fibres from Textile Waste

Heriot-Watt University & Macnaughton Holdings

Nimra Nawaz

Innovate UK

BioReWool: Engineering Biological Pathways for Next-Gen Keratin Fibres from Textile Waste

Nimra Nawaz & Professor Danmei Sun

The Challenge: Wool Waste Lacks High-Value Recycling Pathways

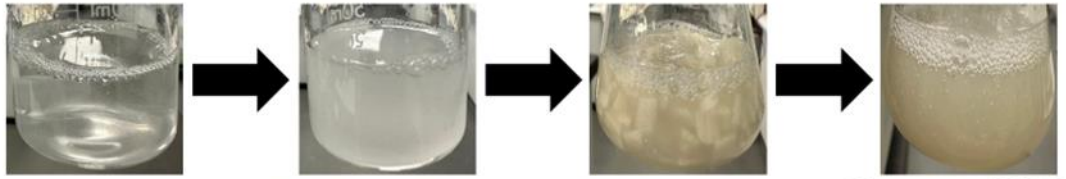
Current mechanical recycling methods compromise fibre quality, creating a barrier to true circular reuse of wool.

WHERE WASTE OCCURS IN THE WOOL LIFE CYCLE

OUR APPROACH - A bio-inspired, protein-preserving dissolution pathway

Pre-treatment

Controlled keratin dissolution



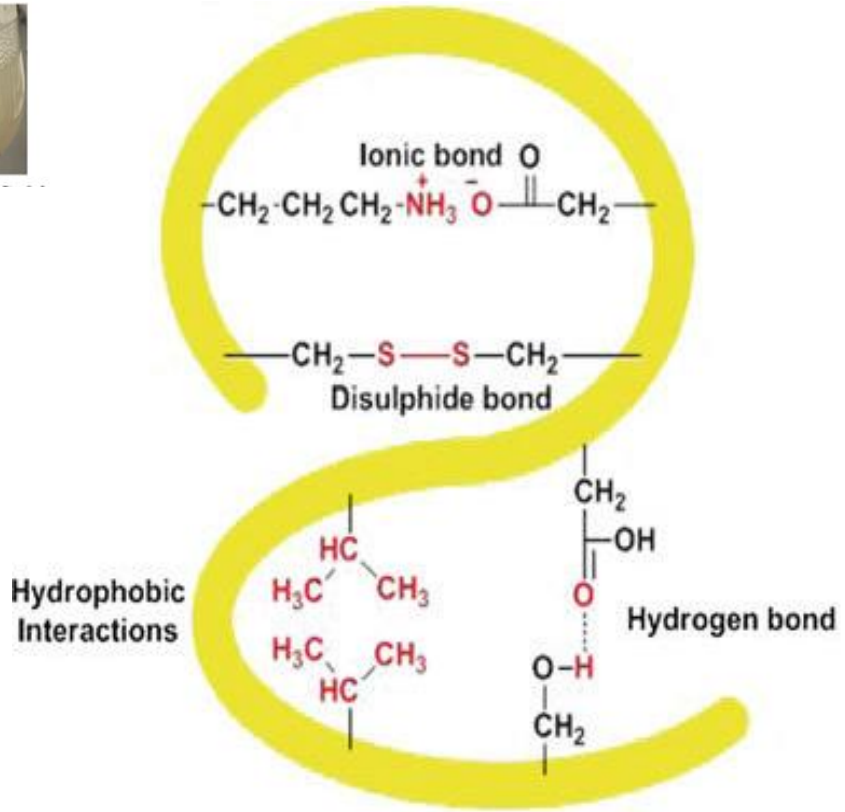
Keratin floc formation

Keratin powder formation

(for only structural characterization

Keratin dope preparation and spinning

KERATIN POLYPEPTIDE BACKBONE



KEY OUTCOMES

- Developed protein-preserving aqueous keratin dissolution system
- Demonstrated direct solution-to-fibre spinning feasibility
- Eliminated dialysis and freeze-drying steps common in literature
- Identified parameters influencing fibre continuity and rheology

INDUSTRIAL ADVANTAGE

- Simplified processing compared to conventional keratin extraction
- More scalable and industry-aligned pathway
- Reduced processing intensity and purification requirements
- Foundation for circular wool waste valorisation

NEXT STEPS

- Optimise viscosity and fibre alignment
- Enhance mechanical performance through structural tuning
- Pilot-scale feasibility assessment within manufacturing context
- Explore collaborative funding for scale-up

Waste recycling

Metagenomic Discovery of Marine Microbial Enzymes for Thermoset Resin Composite Recycling

Scottish Association for Marine Science
& Sustainable Extricko

David Green, Joe Penhaul-Smith

UKRI Innovate UK

Metagenomic discovery of marine microbial enzymes for thermoset resin composite recycling

David Green (SAMS) & Joe Penhaul Smith (Sustainable Extricko)

joe.penhaulsmith@extricko.com

david.green@sams.ac.uk

Challenge addressed

SUSTAINABLE EXTRICKO™

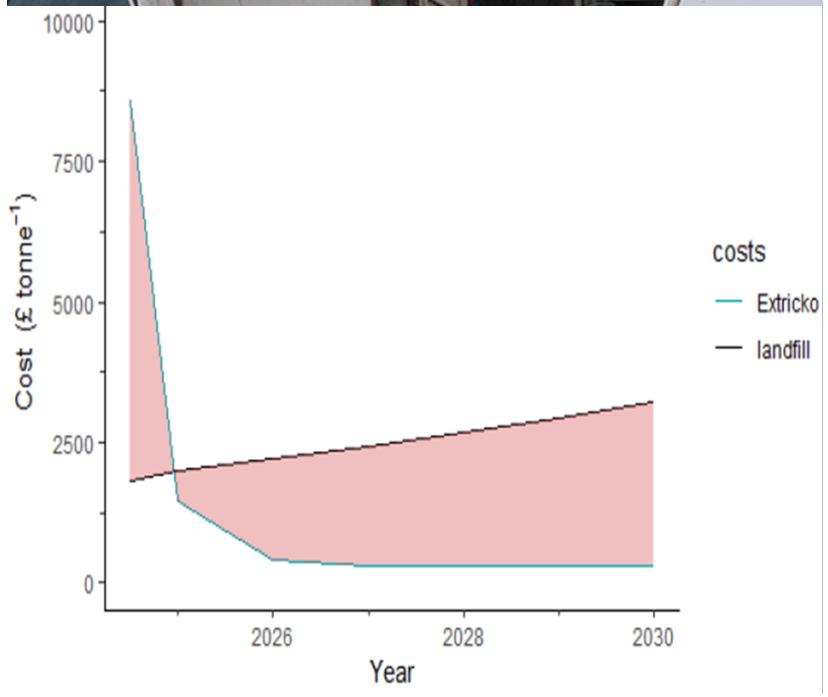
- Thermoset composites are “unrecyclable” at scale, despite being used extensively in the wind energy, automotive, aerospace and marine industries.

- A large and growing problem:
  - 300,000 tonnes of wind blades globally
  - 100,000 tonnes of waste in the UK alone

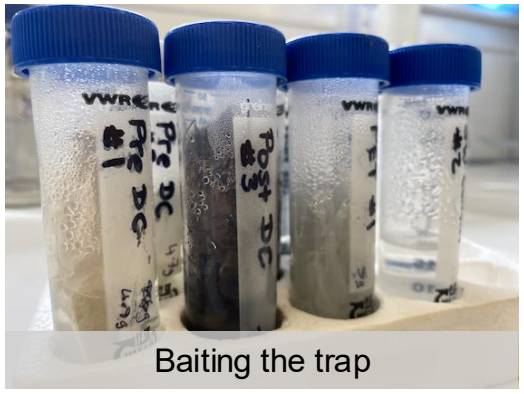
- If abandoned, composites leach microplastics, microfibres and heavy metals into the local environment (Ciocan et al., 2024).

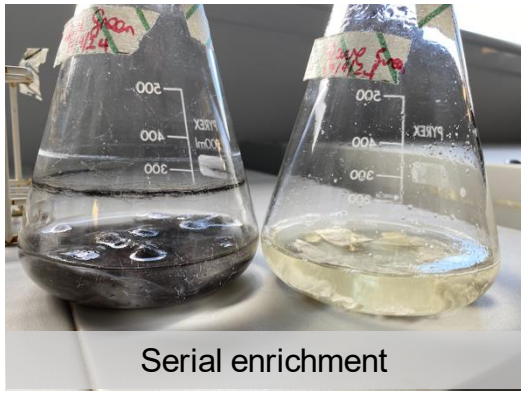
- Sustainable Extricko are building a low cost and carbon footprint recycling solution, using superheated steam (pressolysis).

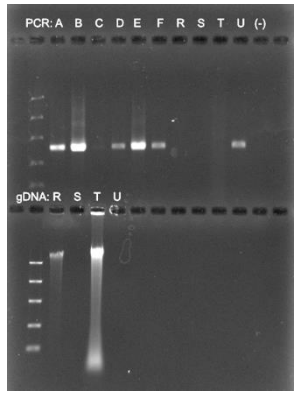
- Closed loop recycling is possible. Biology has the potential to transform these technologies.



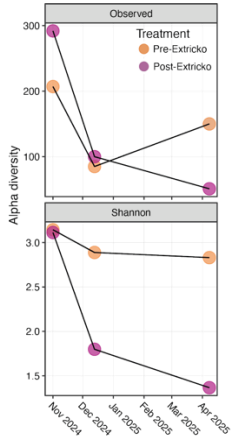
The approach

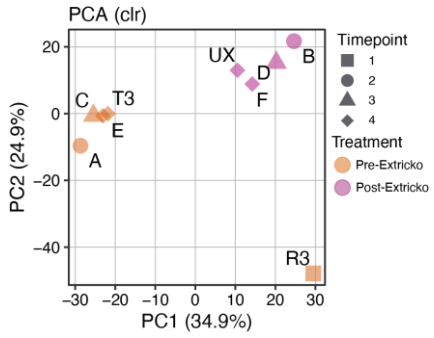

Baiting the trap

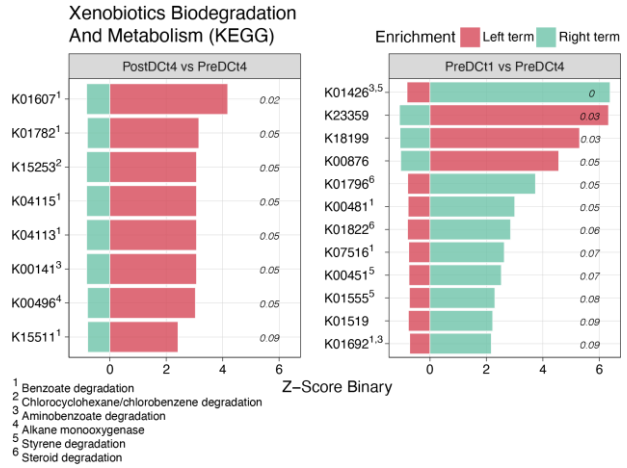

Serial enrichment

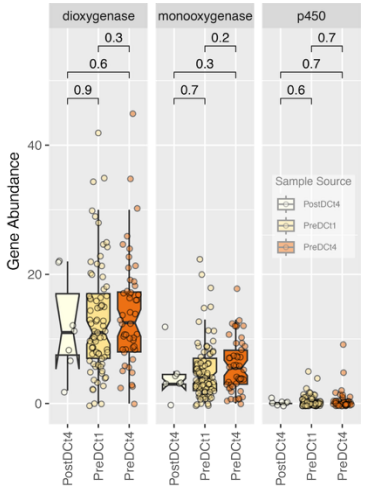


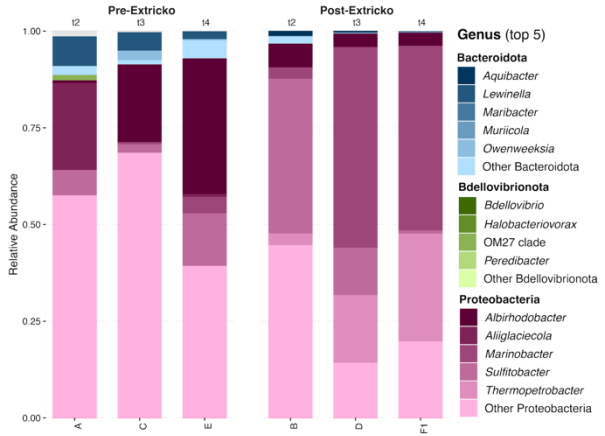
- 16S V3-V4 → Community dynamics
- Shotgun metagenomics → Functional analysis (KEGG)

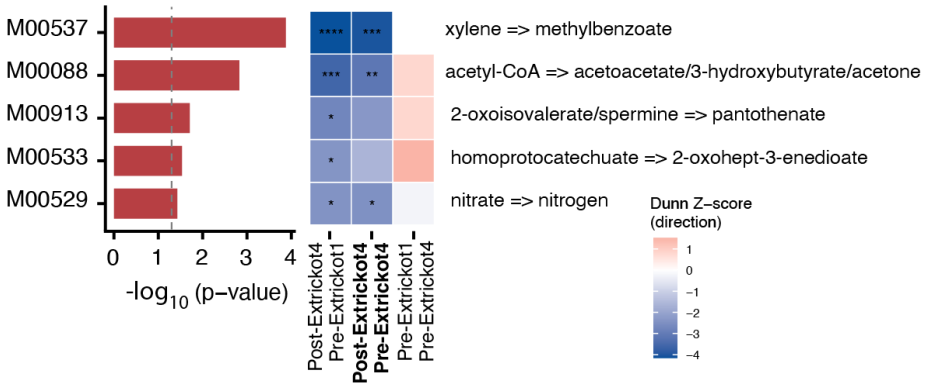


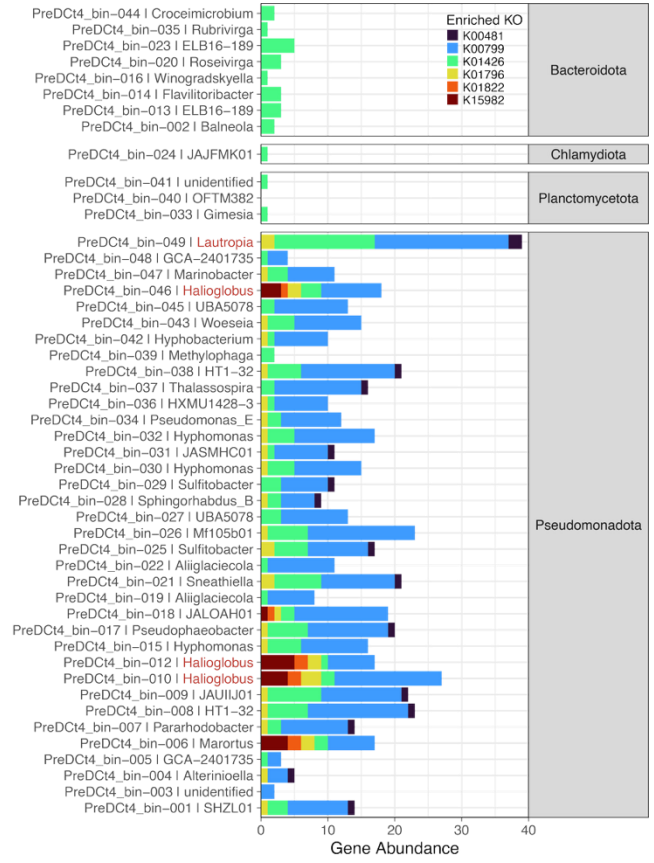












Key achievements

Achievements:

- Enrichment toward microbial communities with higher xenobiotic degradation capacity supports microbial biodeterioration of pre- & post-Extricko thermoset resins
  - Communities differ between substrates, implying substrate-specific adaptions.
- Communities are needed for biodeterioration – no single microbe can do this alone.
- Several MAGs (pre-Extricko & post-Extricko samples) require closer inspection as source(s) of genes and as a putative sole degrader.

What next:

- Biodeterioration is slow and not at a TRL to immediately help Sustainable Extricko.
- Collaboration between SE, Univ. Edinburgh & SAMS will delve more deeply into the data with the goal to identify candidate enzymes for activity analysis.
- SE is seeking to investigate the future of these strains and to apply their extensive scale-up experience to drive commercial outcomes.

Thank you for listening

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Scottish Association for Marine Science

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