Algae could feed and fuel planet with aid of new hi-tech tool

Submitted by synbio on Wed, 12/06/2017 - 16:39

Vast quantities of medicines and renewable fuels could be produced by algae using a new gene-editing technique, a study suggests. Scientists have devised a method that could lead to cheap, environmentally friendly ways of making products for use in the cosmetics, plastics and food industries.

Algae are highly prized for their ability to make useful products, but a lack of engineering tools has hindered basic research and growth of the industry for decades, researchers say. Scientists at the University of Edinburgh sought to improve the efficiency of gene-editing to increase yields of products currently made using algae, including some food supplements. The advance could also enable algae to make new products, such as medicines. The technique uses molecules that act like scissors to cut DNA – called CRISPR molecules – which allow researchers to add new genes or modify existing ones. Until now, scientists have struggled to develop a technique that works efficiently in algae. To overcome this, the team added CRISPR molecular scissors and short pieces of DNA directly to algae cells to make precise modifications to the genetic code. Their new method is more specific and increases efficiency 500-fold compared to previous techniques. The discovery could unleash the potential of the global algae industry, projected to be worth $1.1billion by 2024.The team developed its technique to work in a widely used species of algae – called Chlamydomonas reinhardtii. The method could potentially also be used to engineer crops to increase yields, improve disease resistance or enable plants to thrive in harsh climates.

The study, published in the journal Proceedings of the National Academy of Sciences, was funded by the Biotechnology and Biological Sciences Research Council and Scottish Bioenergy

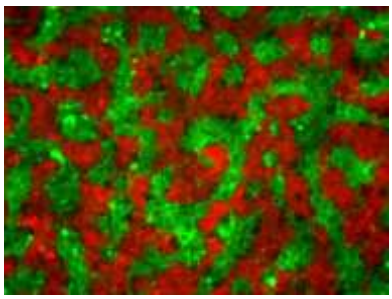
'Our findings mark a key advance in large-scale algal genome engineering. Our technique is applicable to a wide range of species, and could pave the way for the development of designer algae, which has many biotechnology applications.'

Dr Attila Molnar, School of Biological Sciences

Story originally published here

First steps towards self-assembling synthetic tissues

Submitted by synbio on Thu, 11/23/2017 - 09:01



A research team at the UK Centre for Mammalian Synthetic Biology has made first steps towards creating self-assembling synthetic tissues *de novo*.

Prof Jamie Davies, Dr Elise Cachat and Weijia Liu engineered human kidney cells to express synthetic controllers that they then used to prune cells in a layer creating a tissue-like structure.

In conventional forms of bioengineering, tissue-like patterns of cells are created using techniques such as 3-D printing. However, there would be great advantages to getting cells to self-assemble, in much the way they do in Nature.

In previous studies the team created a simple system where human cells, that do not naturally form a pattern, are engineered to express one of two different cell adhesion molecules ('E' and 'P') tagged with different colour fluorescent proteins (red and green). When mixed, the cells naturally partner up with cells expressing the same adhesion molecule type resulting in an animal coat-like pattern of red and green fluorescent patches.

In this study, the team went a step further and added in a so-called morphogenetic factor – one that induces a change in the behaviour of the 'E' cell, in this case triggering the cells to die (apoptosis) in the presence of a chemical (tamoxifen). This time the mix of cells form the 'coat-like' pattern in a monolayer as before, but on treatment with tamoxifen the 'E' cells selectively die leaving holes not unlike the small channels seen in the kidney.

This simple system demonstrates and validates the idea of coupling synthetic biological morphogenetic effectors to synthetic biological patterning devices. It opens the path to engineering more sophisticated structures and, perhaps eventually, tissues.

Publication (open access)

Cachat, E., Liu, W. and Davies, J.A. Synthetic self-patterning and morphogenesis in mammalian cells: a proof-of-concept step towards synthetic tissue development. Engineering Biology, 6 pp.
DOI: 10.1049/enb.2017.0013

ISSN 2398-6182 Available online: 01 September 2017

Above: Reticulum-like holes created after selective apoptosis of cells

Top: Self patterning of red and green fluroescently labelled human cells

Images courtesy of Dr Elise Cachat

Genetic Constructor, simplifying DNA design.

Submitted by synbio on Thu, 11/16/2017 - 11:56

The Edinburgh Genome Foundry (EGF) team are co-authors of a web-based tool that can help researchers design and build the optimal genetic constructs.

Developed in collaboration with Bio/Nano Research Group at Autodesk (a world-leading developer of design software for every industry), Genetic Constructor is a high-level, web-based design tool for synthetic biology.

Genetic Constructor simplifies the design of genetic sequences by organising DNA constructs into composable blocks. This keeps the interface clear and user friendly for even the most complex of projects. The system also makes it effortless to re-use parts between projects or to define combinatorial libraries. This sequence designer has modern features such as nested constructs, templates and the ability to browse external part repositories.

The project started in 2015 as a collaboration between Autodesk and the EGF. We provided initial input in specifications, software design, and a web API to order directly from the EGF via Genetic Constructor.

You can access the software via the EGF website http://www.genomefoundry.org/#/designdna

Published in:

Bates, M. et al Genetic Constructor: An Online DNA Design Platform. ACS Synth. Biol., October 2017

DOI: 10.1021/acssynbio.7b00236

Full article here: http://pubs.acs.org/doi/abs/10.1021/acssynbio.7b00236

Using drug controllable dCas9 transcription factors for multidimensional gene control

Submitted by synbio on Fri, 11/03/2017 - 16:04

Researchers in the lab of Professor Susan Rosser, Director of the UK Centre for Mammalian Synthetic Biology, have built drug-induced degradable variants of the gene-editing tool Cas9 to create an externally controllable system with greater dynamic for regulating gene expression.

Recent advances in the ability to engineer artificial transcription factors (proteins that can control transcription of target genes) have made it possible to design and build novel synthetic gene expression programs. In particular, a mutant version of the clustered, regularly interspaced, short palindromic repeats (CRISPR)-associated protein Cas9, in which the DNA cutting activity of the protein has been disabled (dCas9), has proved a powerful scaffold for the creation of transcription factors with desired functionalities. A variety of functional domains (e.g. activator or repressor domains) can be attached to dCas9 and used to switch on or off gene expression in mammalian cells. However, to date, this tends to result in a relatively stable system imposing a rather static environment on the regulatory circuits in the cells. What would be valuable is a way to create a system with potential for a higher turn-over of the engineered dCas9 proteins whose persistence in the cell could be tunably switched on or off using drugs.

To address this challenge Susan Rosser and post-docs Dirk-Jan Kleinjan, Caroline Wardrope and Si Nga (Susie) Sou have developed a toolkit of dCas9 (or its cousin protein Cpf1) effector proteins, for which protein stability can be modulated by administration of simple drugs, auxin and trimethoprim. In combination these drug-tunable artificial transcription factors can provide multidimensional control of functional activities in cells, which will benefit the construction of complex regulatory circuits with greater switching dynamics

Published in: Kleinjan, D., Wardrope, C., Sou, SN., Rosser SJ. Drug-tunable multidimensional synthetic gene control using inducible degron-tagged dCas9 effectors. *Nature Communications* **8**, Article number: 1191 (2017)

doi:10.1038/s41467-017-01222-y

Highland (SynBio) Games 2017

Submitted by synbio on Fri, 11/03/2017 - 11:59

This year, the UK Centre for Mammalian Synthetic Biology (CMSB) headed north across the glorious new Queensferry Bridge for its very own annual Highland Games (aka Centre retreat) in Kinross.

Over the two days of the event, around 46 of the Centre members and guests found out more about the nuts and bolts of creating a business from Dr Simon Bennett - scientist, serial entrepreneur and now mentor and trainer. Simon encouraged us to all consider being entrepreneurs and helped to bust some of those myths about setting up a business.

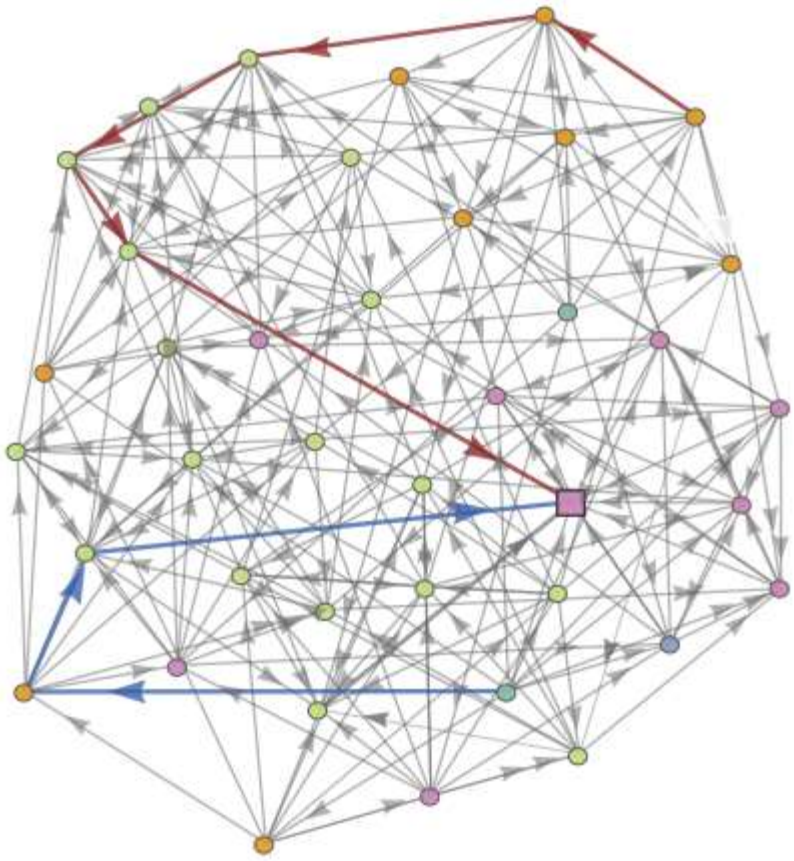
We also took time to ask 'what next' for our Centre, as we head into year four of our five-year award. We brainstormed our aspirations for the Centre for the next decade and more short term practical steps as to how can we get there. This led to teams generating a range of smart new ideas for projects that were later pitched to the Dragon's Den (aka the management team) for cash rewards.

Most importantly of course was taking time out from the daily routine to have some fun. This year we dispensed with inflatables (see here for last year's report) for a rendition of the truly Scottish Highland Games. This largely consisted of throwing or hurling heavy objects (wellies, cabers [poles], lorry tyres, and staines [stones]!) with increasing inaccuracy as the daylight failed (largely the fault of the centre manger for forgetting about daylight saving). There's much to be valued in the cover of darkness!

SynthSys Director, Alistair Elfick, demonstrates a Successful caber throw

New model provides insights into microbial evolution

Submitted by synbio on Mon, 10/23/2017 - 09:29



Researchers at SynthSys have developed a novel modelling approach to predict how microbial communities might adapt in response to their changing environment. Such insights could be valuable in understanding how microbial communities emerge, establish, and diversify.

Communities of microbes grow on mixtures of metabolic resources, and there is often intense competition for each type of nutrient. Microbes in natural communities, for example in the gastrointestinal tract, do not try to consume all the available substrates but, instead, each species specializes to a few substrates.

This metabolic specialization is driven by cellular trade-offs, where importing and metabolizing one resource reduces a microbe's ability to import and metabolize another. Random genetic mutations can affect how these trade-offs are balanced, and communities evolve with a complex interdependence on their ecology. Consequently, we do not understand how, and under what conditions, this evolutionary process leads to communities that are stable and long-lived.

Dr Christos Josephides and Prof Peter Swain have developed a mathematical model that integrates aspects of intracellular constraints, ecological dynamics, and random mutational processes to describe the evolution of microbial communities. Using the model, the

researchers could re-construct all evolutionary histories that lead to the same stable community and discovered that properties of these evolutionary trajectories can be used to predict the type of stable community that ultimately forms. They can therefore forecast whether a community will, for example, eventually collapse or diversify.

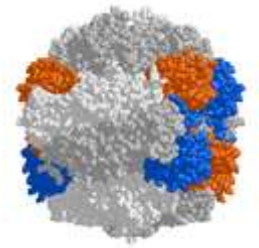
Published online: Josephides, C. and Swain, P. Predicting metabolic adaptation from networks of mutational paths. *Nature Communications* (2017) Vol 8 (1) 685

DOI: 10.1038/s41467-017- 00828-6

Image: An example of a network of evolutionary trajectories, which visualizes the evolutionary dynamics of a microbial community. Nodes represent different community states and are coloured according to how that community exploits the environment; arrows represent eco-evolutionary transitions, where a mutant population arises and out-competes a resident population. Squares show stable communities, resistant to mutation; circles show transitory ones. Two sample trajectories are indicated in red and blue.

Virtual reality makes kids' play of photosynthesis

Submitted by synbio on Thu, 10/12/2017 - 13:53



The Centre is using virtual reality to provide the public with an understanding of how plant photosynthesis works.

Dr Alistair McCormick and PhD student Hamish Todd have developed an interactive educational tool that involves a virtual reality (VR) game in which users need to find a key enzyme involved in photosynthesis (Rubisco), pick it up and collect carbon dioxide molecules while avoiding oxygen molecules. The project, funded by the Phyconet network, aims to provide insights for children and the public into biology.

Users put on the VR headset and hand-held controller and can immerse themselves within a 3D environment. The program 'shrinks' the user to the size of an atom and places them inside a chloroplast. The VR system can track their movement so they can walk around this VR chloroplast picking up enzymes and molecules.

The game was designed in collaboration with Hamish (from the lab of Prof Andrew Goryachev), who previously worked in the gaming industry. The lab first trialled it at the Midlothian Science Festival in Edinburgh last year. In the longer term, the aims are to introduce the kit for use in schools, and to develop more biology educational games for the platform.

Alistair says: "The idea evolved from Hamish's PhD, which is focused on developing a VR tool for analysing protein crystal structure data. Our VR game offers a simplified way to visualise how proteins function, and can impart basic knowledge about substrates and competitive interactions to a wide variety of age groups. Overall, VR is a very promising learning tool for interactive teaching of scientific processes."

Phyconet is a BBSRC Network in Industrial Biotechnology and Bioenergy (BBSRC NIBB), a UK-based network enabling biologists, engineers and industrial partners to consolidate their knowledge and expertise to unlock the potential of microalgae.

Image: Spacefilling structure of RuBisCO created using Rasmol and the 8RUC file from the Protein Data Bank. Transferred from en.wikipedia to Commons.

Full speed ahead for the UK Bioeconomy

Submitted by synbio on Tue, 09/26/2017 - 16:09

The Centre attended the KTN Chemistry and Industrial Biotechnology (IB) Showcase in York on Sept 20 and 21 representing the Synthetic Biology Research Centres and Facilities across the UK, which now amounts to ~£300 million UK Government investment.

Chemistry and IB are important sectors in the supply chain for a wide variety of products including medicines, materials, low carbon fuels, batteries, personal and household care products and food. Moving from petrochemical to 'bio' feedstocks is not only more sustainable but offers an opportunity to design in new properties for existing and future products. The sessions on functional materials, new batteries, personal care and products for healthy ageing showed just how diverse and large the target markets are. Low carbon fuels remain of interest, of course, with some encouraging successes getting biofuels 'out on the road.'

In what was a well-attended meeting, several hundred industrialists, academics, funders and policy makers gathered to discuss success and look to the future. The event, which merged the IB and Chemistry Innovation showcases, showed signs of more 'joined up thinking' across industry sectors, suitably timed, perhaps, for the merging of Research Councils and Innovate UK next April.

Synthetic biology benefited from an entire session chaired by Professor Susan Rosser, Director of the UK Centre for Mammalian Synthetic Biology. A number of the up-and-coming synthetic biology companies in the UK presented including Ingenza, LabGenius, Colorifix (for bacterial dyes), Customem (for designer water purifying polymers) and Cambridge Consultants (doing a big push in synbio). Great to see some of these start-ups beginning to get traction with funders and develop real game-changing products and services.

In the end, though, it's all about the (bio)economy. Apparently, we are lagging behind Europe where many countries launched strategies for their bioeconomy years ago. However, the leadership groups for chemistry, IB, medicines, synbio and agritech are plotting a joined-up strategy for the UK's own bioeconomy roadmap, which should be launched sometime soon. Hopefully generous funding will then flow to help us catch up. Perhaps our synbio investments will also accelerate our move towards a more sustainable future.

Synthetic Biology Opens Doors

Submitted by synbio on Tue, 09/26/2017 - 15:20

This year, Doors Open was even bigger and better than last as we welcomed over 200 visitors to the Roger Land Building on Saturday 23rd September to find out more about the great science we do within its walls.

As part of the national Door's Open weekend, staff from SynthSys, and this year's Edinburgh undergraduate iGEM team, came along to engage the public with some of the great projects ongoing across the Centre and School of Biological Sciences. Children had an opportunity to engineer their own fuzzy felt engineered bacteria, watch how bacteria can clean up dirty water, and how robots can take the pain out of pipetting!

We were particularly delighted to welcome members of the Colouring Outside the Lines group of autistic girls interested in STEM subjects. They came for a private viewing before the opening to the general public and asked some very challenging questions.

The University constructed the Roger Land Building in the 1960s to house the Animal Research Organisation. The architect, Sir Basil Spence, is better known for his modernist design of Coventry Cathedral destroyed during the Second World War.

The Roger Land Building has since housed the Institute for Stem Cell Research and has recently been renovated to house researchers from the School of Biological Sciences including the hub for the UK Centre for Mammalian Synthetic Biology.

Ethiopia explores synbio for vaccines

Submitted by synbio on Mon, 09/25/2017 - 16:52

In its continued efforts to develop international collaborations, the UK Centre for Mammalian Synthetic Biology hosted Mr Birhanu Hurisa, co-director of the Vaccines Directorate of the Ethiopian Public Health Institute (EPHI) based in Addis Ababa.

In Ethiopia, Mr Hurisa leads a large team that produces a cell culture based rabies vaccine for use in humans and rabies monoclonal antibodies for diagnostic and therapeutic applications.

The EPHI is Ethiopia's leading public health institute carrying out research across a wide range of health issues of particular relevance to East Africa. Mr Hurisa is an experienced molecular biologist and virologist and was interested in finding our more about how synthetic biology might assist in his work.

Over the four days of his trip, Birhanu spent a day in the lab of Professor Susan Rosser, gave a talk to veterinary researches at the Roslin Institute, visited the Genome Foundry and made introductions to the Directors of the newly NIHR-funded TIBA partnership (Tackling Infections to Benefit Africa) Prof Mark Woolhouse and Prof Francisca Mutapi (see photo). We hope that Ethiopia will be able to become a key TIBA partner in the future.

During his trip, Birhanu made many new connections, sampled some great Scottish hospitality, and is looking forward to developing some productive collaborations in the future.

Photo Courtesy of Seth Amanfo, TIBA

From left to right: Prof Mark Woolhouse, Mr Birhanu Hurisa, Dr Liz Fletcher, Prof Francisca Mutapi

Prestigious government appointment for Prof Tait

Submitted by synbio on Mon, 09/25/2017 - 16:26

Professor Joyce Tait, Director of Innogen and a member of Edinburgh synthetic biology research centres, has been made a member of the UK Government's Science and Technology Council.

The Council for Science and Technology advises the Prime Minister on strategic science and technology policy issues that cut across the responsibilities of individual government departments. This is a prestigious appointment and is a reflection of the esteem with which Joyce and her research are held.

Joyce has a background in both natural and social sciences and specializes in innovation-governance-stakeholder interactions in the life sciences. She was awarded a CBE for services to the social sciences in 2005 and an honorary doctorate of the Open University in 2009. She is a Fellow of the Royal Society of Edinburgh, sits on the Synthetic Biology Leadership Council and the Boards of both the Industrial Biotechnology Innovation Centre and the Roslin Foundation.

Hands-on Research at Summer School

Submitted by synbio on Tue, 08/15/2017 - 17:34

For the second year Dr.Teuta Pilizota took part in a two-week long summer school called Hands-On Research for Complex Systems at ICTP in Trieste, Italy (https://www.ictp.it/). She was joined by her post grad student Dario Miroli and demonstrated an experiment on osmosis in individual bacterial cells using a custom built microscope worth ~£400.

The School is designed to introduce graduate students and young faculty from developing countries to table-top scientific research on problems at the frontiers of science. The table top design should either serve as an example of a teaching lab project for educational purposes, or, even better, exemplify how cutting-edge questions can still be asked with very limited monetary resources. Experiments on physical, chemical, and biological systems are conducted with modern yet inexpensive digital instrumentation, and the laboratory work is complemented by mathematical modeling and data analysis using Matlab. The Hands-On Schools foster the development of scientific leaders in less developed countries.

Each day for two weeks, small groups of 2-6 participants and two instructors work closely together on an experimental project, where the projects are rotated. In addition, the participants work with faculty on professional development skills (writing, poster presentations and flash talks). They can then apply the learning on their own poster and a flash talk, which are presented during the two weeks with a prospect of winning poster awards.

The School faculty are all eminent scientists who have conducted frontier table-top research published in leading international scientific journals such as *Nature*, *Science* and *Physical Review Letters*. While many areas of research now involve large numbers of collaborators using very expensive instrumentation, the Hands-on Research Schools focus on frontier research that can be conducted by individuals or small groups using rather modest instrumentation. Examples are taken from the research of the faculty members.

Dario and Teuta describe the experience at the School as probably the most intense and rewarding teaching experience they have had.

You can find out more about the two-week long summer school on the website (http://www.handsonresearch.org/).

Centre partners with Sphere Fluidics in £1 million award to develop Desktop Genome Editing Platform

Submitted by synbio on Mon, 07/31/2017 - 08:55

The UK Centre for Mammalian Synthetic Biology is a partner on a newly awarded £1 million grant to UK company Sphere Fluidics to develop the world's first automated single cell genome engineering platform.

Cambridge-based company Sphere Fluidics is a leader in technology for single cell analysis and has developed and sells commercially a single cell analysis and characterization system called Cyto-Mine® for the biopharmaceutical discovery and development market.

The aim of the funded project is to generate an automated, benchtop device for the creation of high-value, genome-edited cell lines. Professor Steve Pollard, a Centre investigator and CRUK Senior Fellow based at Edinburgh's Centre for Regenerative Medicine, will focus on engineering various gene reporters into both pluripotent stem cells and more restricted brain stem cells. These technologies will also be explored for the delivery of synthetic transcription factors at single cell level to try and program and reprogram stem cell differentiation'.

Steve says: 'We are excited to be part of this partnership, which brings our expertise in stem cell engineering to bear on the innovative microfluidics platform developed by Sphere Fluidics. The aims are perfectly aligned with those of our synthetic biology Centre, to help develop the tools and technologies that will help realise next generation regenerative medicine using synthetic biology approaches."

Genome editing is rapidly becoming an essential tool across all areas of life sciences R&D (*e.g.* basic research, diagnostics, gene therapy and regenerative medicine, synthetic biology and bio-manufacturing).

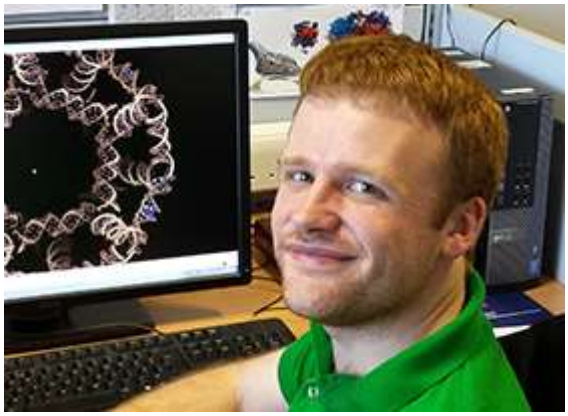
The other partners on the project include Horizon Discovery (UK) and Twist Bioscience (USA), which bring translational genomics and gene synthesis expertise, respectively, to the partnership.

The grant was an Open Innovation Grant from Innovate UK which was open to companies in every industry in the UK.

Sphere Fluidics press release can be read in full here.

Beauty of viruses celebrated in interactive documentary

Submitted by synbio on Tue, 07/11/2017 - 10:46



Friday 30th June saw the world premiere of a documentary that celebrates the shapes of some of the world's most deadly pathogens.

Viruses, in spite of the pain they cause us, are some of the most beautiful creatures in the world, covered in varied and intricate patterns - the patterns on Zika virus actually have connections to medieval Islamic art. The documentary entitled *Virus, the Beauty of the Beast* is an interactive documentary, three years in the making, about the patterns we find in the shapes of viruses, and how understanding them can help us fight those viruses.

Created by Hamish Todd, a BBSRC Eastbio PhD student based in the lab of Dr Andrew Goryachev in the Centre for Synthetic and Systems Biology, the documentary uses animation and simulation to explore how the patterns in the shape of viruses tell us about how the function. It can also inform us about the human designs that they appear in such as buildings, origami and alloys.

'When asked about his inspiration Hamish said 'Mat*hematics is beautiful to me, and mathematical biology is exactly twice as beautiful; but so many people are closed off from being able to examine and contemplate the things that we scientists are privileged to spend all day with. With this documentary I wanted to offer that opportunity to as many people as possible'*

The documentary has a particular focus on HIV, Zika virus, and Hepatitis. You can watch it all online at http://viruspatterns.com

Connect and Collaborate: The Future for Lab Automation

Submitted by synbio on Mon, 07/03/2017 - 17:09

On June 8th, the Centre hosted a thought-provoking workshop to explore the possibilities for lab automation with Anatune, a leading provider of lab automation.

Anatune have been working with Dr Hannah Florance, a Metabolomics Specialist at the UK Centre for Mammalian Synthetic Biology, to design and support an analytical solution for the automated sample preparation of biological material prior to analysis by GC-QTOF. Hannah and her colleagues currently use the system to carry out a range of tasks prior to direct injection into the Agilent 7200 GC-QTOF including solvent extraction, derivitizing extracted materials and preparing calibrants for standard curves. The modular setup – more affectionately referred to as 'Stella' (see photo left) – is highly flexible providing the potential to automate the whole process from extraction to detection.

Attended by 12 mass spec experts from across the region, the focus of this collaborative workshop was to explore the impact of lab automation and benefits on current lab practice and research in bioscience and biotechnology as well as other market sectors including food and fragrance, fast moving consumer goods, water and environmental technologies, pharmaceuticals and forensics. Representatives from academia, industry as well as industrial biotechnology specialists tired of carrying out tedious and lengthy sample preparation and analysis techniques met to discuss and share ideas on the potential benefits of lab automation.

The group spent some time discussing the benefits of automated set ups including:

- Freeing up more time for thinking and downstream in-depth analysis

- Providing a faster and broader scope for method development and validation
- Reducing sample preparation with better control over incubation times
- Reducing exposure to nasty chemicals
- Flexibility to carry out a variety of projects for colleagues both within and outside of the University who use similar sample preparation steps and require the high quality data provided by accurate mass GC-QTOF

If you would like to contact Hannah to enquire about preparation and analysis of samples please call her on 0131 650 6044 or email at Hannah.Florance@ed.ac.uk.

About Anatune

Anatune serves analytical chemists in the UK and Ireland who wish to improve on turnaround times, reduce cost per sample and improve the data quality observed with manual sample preparation. Anatune integrate automated sample preparation with Gas Chromatography (GC), Liquid Chromatography (LC) (-Mass Spectrometry) and Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) to provide flexible and reliable analytical on-line/in-line, real-time and process analysis solutions which generate high quality data on a daily basis. If you want to know more about lab automation possibilities for your own lab workflows then please call or email Anatune on 01223 279210 and enquiries@anatune.co.uk.

Parasitology a focus for new collaborations

Submitted by synbio on Fri, 06/09/2017 - 11:41

Centre members braved biblical summer floods on a trip to Aberystwyth to discuss how synthetic biology tools and technologies might shine some light on the remaining challenges in parasitology.

Professor Susan Rosser, Dr Liz Fletcher and Dr Gaynor Campbell were hosted by Professor Karl Hoffmann of the Barrett Centre for Helminth Control (BCHC), a centre of excellence in research into a variety of parasitic worms. Helminth (worm) infections continue to be the cause of some of the most devastating chronic diseases on the plant. However, they are among the most difficult infections to manage because of the complex life cycle of parasitic worms, which makes the development of diagnostics, therapeutic drugs and prophylactic vaccines difficult. The BCHC is driving innovation in this area through new collaborations and partnerships spanning previously untapped disciplines – synthetic biology is just one of them.

The Edinburgh team enjoyed a stimulating day of discussions around parasitology as well as meeting other members of the Institute for Biological, Environmental and Rural Sciences (IBERS). They gave a lunchtime seminar to staff and students, which generated much animated discussion around the many possibilities arising from the reduction in costs of DNA and the new cell engineering tools generated using synthetic biology principles.

During the day, the team visited the ‘hatchery’ where the snails that are the natural hosts for several worm infections are grown, and the drug screening unit where Prof Hoffmann has developed a unique phenotyping capacity using living worms. A trip to the sister IBERS

campus provided an overview of the impressive robotics and plant imaging in the National Plant Phenomics Centre and the BEACON Centre of Excellence for Biorefining, a £20M investment in scale up of industrial biotech processed for generating high value chemicals from waste. The team also found out more about the University's plans for an innovation centre that will capture more of the translational food and agriculture science for which the University is renowned.

Many projects were discussed and the team is already planning a return visit to Edinburgh in the near future. Many thanks to Professor Hoffmann and his team for their hospitality.

Pictures courtesy of Jessica Longworth at the Barrett Centre for Helminth Control (BCHC)

Pragmatic approach to responsible innovation proposed

Submitted by synbio on Thu, 05/25/2017 - 08:56

A study proposes a radical new approach to the responsible development of innovative products, processes and services by companies and organisations operating in the bioeconomy and related industry sectors.

Writing in the May issue of the journal *Engineering Biology*, Professor Joyce Tait of Innogen and the UK Centre for Mammalian Synthetic Biology proposed a new approach that departs from current responsible research and innovation (RRI) models in that it recognises the very different challenges faced by innovating organisations. The model moves away from the politicised perspectives that have dominated many engagement initiatives on disruptive innovations like synthetic/engineering biology, and to focus on more practical downstream outcomes, the extent to which they will fulfil the aspirations of ordinary citizens, and will comply with prevailing industry norms of responsible behaviour.

The proposed consolidated responsible innovation framework builds on the framework developed in 2012 by the then Technology Strategy Board, implemented using the anticipate, reflect, engage and act approach devised by UK research councils. It distinguishes between routine, company-specific aspects of responsibility, expected to be addressed within an organisation's standard operating procedures, and project-specific aspects requiring regular appraisal throughout the development of an innovation. It is designed to be simple and feasible for a company to implement within a commercial environment.

You can read this article here.

SynBioBlog: Building Human Artificial Chromosomes on the other side of the world

Submitted by synbio on Tue, 05/16/2017 - 11:10

"I am just off to Japan to do some experiments." This was the easiest way I could explain to my family that I was going to Japan to learn how to synthesize artificial chromosomes.

I joined the University as a Postdoctoral Researcher in the lab of Prof. Bill Earnshaw, funded through the UK Centre for Mammalian Synthetic Biology. We are working on a project that uses Human Artificial Chromosomes (or HACs) to understand the differences in functional chromatin states between the centromere and the flanking heterochromatin.

In April 2017 I visited the lab of Prof. Hiroshi Masumoto, a leading expert in the HAC field and a long-standing collaborator of Prof. Earnshaw based at the Kazusa DNA Research Institute in Kisarazu (Japan). The Masumoto group specializes in HAC synthesis through the transfection of human cell lines with BACs (Bacterial Artificial Chromosomes) containing long DNA repeats. Their goal is to improve the stability and efficiency of HACs so that, in the future, they could be used as vectors for gene delivery for treating human diseases.

Profs Masumoto and Earnshaw pioneered the creation of the first human chromosome with a conditional centromere: in this system the centromere (the region of a chromosome responsible for the correct segregation of chromosomes in daughter cells during cell division) can be suppressed or bound by specific chromatin modifiers expressed as fusion proteins with special targets. This system allows us to study the effects of changes in the epigenetic landscape on centromere function.

I spent two weeks at Kazusa DNA Research Institute learning cloning techniques from experts in the HAC field. I will now use what that knowledge to build a new HAC with two binding domains suitable for targeting with fusion proteins; one domain at the centromere and the other one at the flanking heterochromatin. This would help to understand how the different regions interact with each other.

During my trip I had the chance to exchange ideas with many people and to strengthen the relationship between our groups, both from a scientific and personal point of view. I experienced that even when there are cultural or linguistic barriers it's easy to communicate with collaborators who are willing to share their knowledge and who are as passionate about their job as you are.

This journey had a great impact on both my knowledge and my motivation: there's always something new to learn, especially on the other side of the world.

Dr Elisa Pesenti, Postdoctoral Research Associate, School of Biological Sciences

Photo: Elisa (centre) and the her hosts, the Masumoto lab under the cherry blossom

SAW Trust inspires for second year

Submitted by synbio on Tue, 05/02/2017 - 12:48

On April 21st, SynthSys welcomed Jenni Rant and the SAW Training team back to Edinburgh for our second annual training event bringing their innovative approach to teaching science to children using the power of words and pictures.

This year, thanks to support from Lorna Macdonald, Principal Officer Creative Learning for Schools and Lifelong at the City of Edinburgh Council, we had great participation from local primary schools for the entire day.

Jenni Rant (SAW lead and scientist) and colleagues Mike O'Driscoll (writer) and Chris Hann (poet) ran another inspirational workshop to show how a blended programme of fun hands-on science experiments coupled with imagery, poetry and art can convey in a meaningful way often complex science by harnessing a child's natural curiosity and creativity.

At the end of the workshop we formed teams consisting of teacher, scientist, artist and writer got together to plan a themed workshop for seven primary school classes in the Edinburgh region.

We would like to extent our thanks to all the writers and artists who joined us for the day to help make the event such a success.

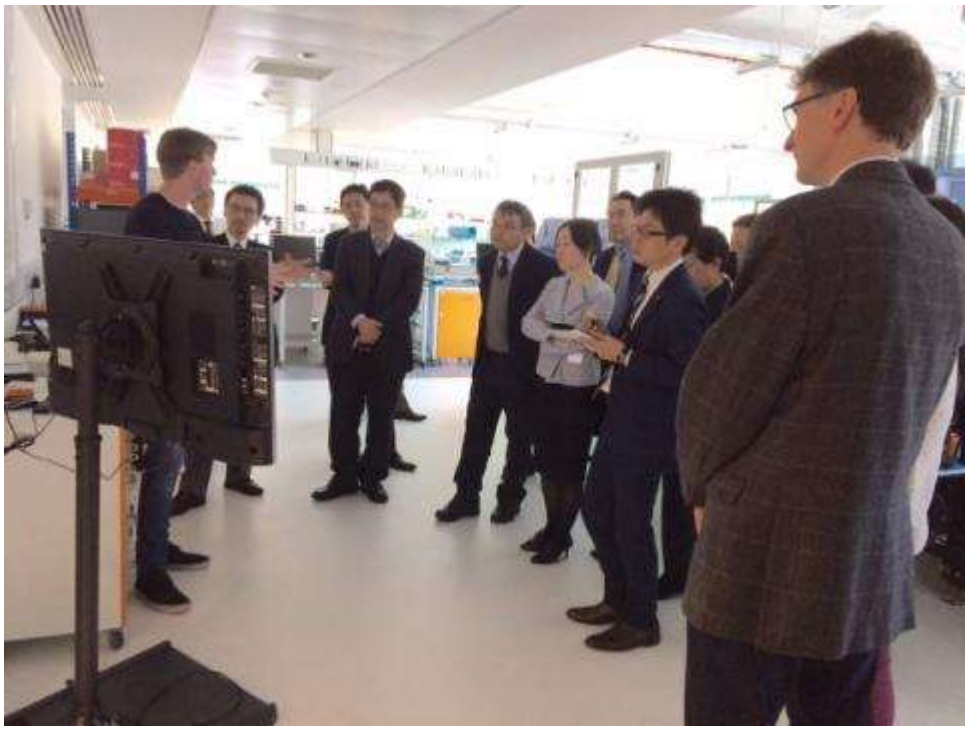
About the SAW Trust

You can find out more about the SAW Trust at www.sawtrust.org and follow them on Twitter @SAWTrust.

The SAW Trust was founded by Anne Osbourn @AnneOsbourn1 a practising scientist and currently Associate Research Director and Institute Strategic Programme Leader, Plant and Microbial Metabolism at the John Innes Centre in Norwich. She has an international reputation for her work on plants and plant diseases. She is an ardent advocate of science and scientists engaging more fully with society. Her passion is inspiring children about science, and she is fascinated by the processes of creativity and exploration that underpin both scientific and artistic endeavour.

Foundry welcomes VIP visitors from Japan

Submitted by synbio on Tue, 05/02/2017 - 08:58



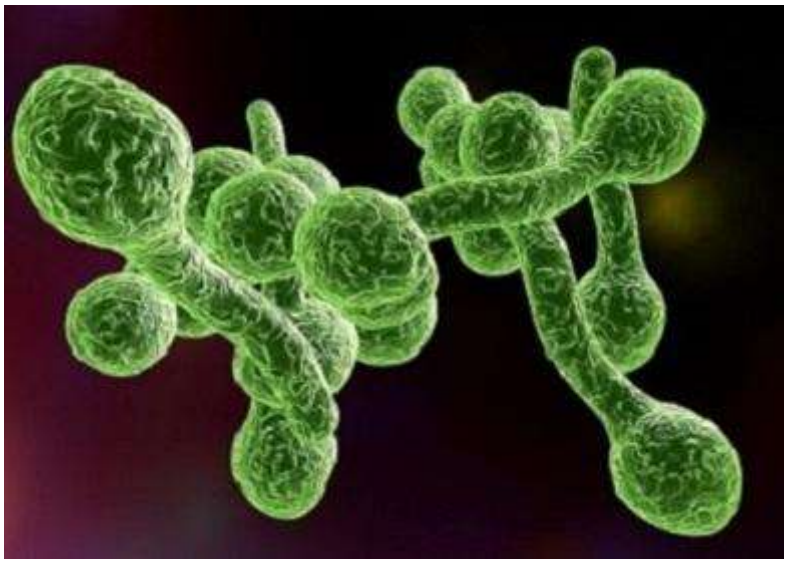
The Edinburgh Genome Foundry and School of Biological Sciences were delighted to host a VIP visit from fourteen delegates from Japanese academia, industry and government on Thursday April 27th.

Delegates enjoyed a tour and talk in the Foundry followed by an overview of research ongoing in the School, presentations of on three distinct areas of synthetic biology research and an overview of the University's strategy for industry engagement. The delegation, coordinated by Japan's Ministry of Economy, Trade and Industry (METI), then paid a visit to two local synthetic biology companies Ingenza and Synpromics, with whom the Centre collaborates.

The Centre ws particularly pleased to welcome back Professor Akihiko Kondo, a professor from the University of Kobe, who had paid a visit to the Centre in February 2016.

Evolutionary resilience makes for better bioproduction

Submitted by synbio on Tue, 05/02/2017 - 08:44



SynthSys member Dr Matteo Cavaliere and colleagues have recently published a mini-review discussing why the evolutionary resilience of microbial communities should be considered when designing robust biotechnological applications.

Microbial communities are the mainstay of industrial biotech processes. However, the efficiency and productivity of these applications often depends on the presence of cooperative interactions between microbes. Cooperative behaviours can be damaged by the emergence of ‘cheating' cells that benefit from cooperation but do not contribute to them. On the other hand, cooperative interactions can be stabilized by other factors such as spatial segregation, regulatory systems coupled to the environmental conditions, and even by horizontal gene transfer.

Cooperative interactions bolster microbial communities against stress and can help facilitate the evolution of more complex (and potentially more desirable) traits in industrial microbial communities.

The authors suggest several modelling techniques and focus on cellular cooperation, discussing various applications in which it is crucial to avoid the spreading of detrimental mutants.

Cavaliere, M., Feng, S., Soyer, O., and Jimenez, J. Cooperation in microbial communities and their biotechnological applications. *Environmental Microbiology*, Accepted manuscript online: 26 April 2017 - DOI: 10.1111/1462-2920.13767

http://onlinelibrary.wiley.com/doi/10.1111/1462-2920.13767/full

Contemplating the social dimensions of Sc2.0

Submitted by synbio on Tue, 05/02/2017 - 08:38

Dr Jane Calvert and Dr Erica Szymanski have published a blog on PLOS Synbio exploring how the Synthetic Yeast project provokes new questions around the social ramifications of this major endeavor.

Whole-genome engineering appears to be moving forward apace. The first synthetic biology effort to build a comprehensively re-designed eukaryotic genome recently made news with seven papers in a special issue of *Science* (see also 'Extreme Makeover'). The project – *Saccharomyces cerevisiae 2.0*, more often called Sc2.0 or "synthetic yeast" – is the first effort to synthesize the genome of a eukaryote.

Social scientists, including Jane and Erika, have been working closely with the Sc2.0 researchers are now ask: How does the Sc2.0 project disrupt standard biological paradigms? What new scientific questions does it provoke especially around the social shape of biology?

Ethical and safety concerns are often discussed but how does the Sc2.0 (and other genome engineering) projects change how we relate to other organisms, how we define the limits and possibilities of science and engineering, and the shape of future worlds in which we'll all live together. What else is being changed when scientists change the genome of "humble" baker's yeast? *Read this thought-provoking article here* http://bit.ly/2p0zgjf

Centre welcomes International Science Advisory Board

Submitted by synbio on Fri, 04/07/2017 - 10:44

The UK Centre for Mammalian Synthetic Biology had its first Board Meeting on April 3 and 4. Over the two days, the Board heard about progress across all active research work packages as well as several new avenues of research. The managers of the Centre's specialist research facilities discussed the capabilities that they have been building over the past two years, providing expertise in metabolomics, genome assembly, microscopy, microfluidics, cell transformation and data management for the Centre's research community. The Board enjoyed a tour of the Genome Foundry and Prof Ron Weiss, a pioneer in synthetic biology and professor of biological engineering at MIT, then gave a keynote on his own research in mammalian synthetic biology.

We would like to thank our Board, all our Centre members including our new PhD students, and the management team for helping make this a very successful event. Feedback from the Board was excellent and we are grateful for their valuable recommendations, which we will work hard to implement over the coming months.

SynBioBeta London 2017

Submitted by synbio on Fri, 04/07/2017 - 10:33

In what is a 'must attend' fixture in the synthetic biology events calendar, the 2017 annual meeting of SynBioBeta provided a useful window on the UK and international synthetic biology startup landscape.

Our Centre was very visible at the meeting: Prof Joyce Tait participated in fireside chat with Mark Lynas (ex GM-activist and now convertee to synbio) around the thorny GM regulatory issue. Dr Liz Fletcher moderated a session on designer biomaterials. Dr Lorraine Kerr (who arguably drew the short straw) had to go on the networking cruise down the Thames with SBB delegates on possibly the warmest day of the year yet. Great to see our SynthSys PhD and postdocs hard at work networking during the event.

This year, the UK Synthetic Biology Research Centres and Foundries shared a stand to present a more cohesive and joined-up promotion of the Government's substantial investment in synthetic biology. To do this, we developed some new banners and Anais Moisy, user-experience designer in the Edinburgh Genome Foundry, applied her creative skills to generating an exciting new design (see image). As exhibitors, we had plenty of interest in what we do – from high school students to multinational company executives – and it remains a great event for catching up with the key players in the field and making new connections. Over the years it has been great to see UK startups maturing into credible and competitive businesses.

Exploring Grand Challenges

Submitted by synbio on Fri, 04/07/2017 - 10:30

The Centre has continued to explore the potential opportunities for synthetic biology in developing regions of the world over the past month with funding from two Global Challenge Research Funding (GCRF) awards.

On March 15-17, Professor Susan Rosser and Dr Liz Fletcher headed to Nairobi to join a workshop organized by Prof Paul Freemont of Imperial College London in collaboration with Kenya's National Commission for Science, Technology, and Innovation. Over the three-day event, we heard from representatives from research institutes across East African nations about ongoing research activity, the regulatory and policy framework on pertinent issues such as GM. Round table discussions helped to tease out the local needs for health and welfare of humans and animals, the environment, and opportunities for the bioeconomy. Imperial College, Cambridge and Edinburgh researchers provided overviews of research, training, and entrepreneurship activities in synthetic biology from across the UK. Our African colleagues are intrigued with the possibilities offered by synthetic biology and there was a great deal of enthusiasm to leverage GCRF funding to build capacity and capability locally. You can read a bit more about the outcome of the meeting here http://buff.ly/2mvKX56

On March 24 and 25, the Centre invited seven eminent professors from Chinese universities and research institutes to Edinburgh to explore opportunities for collaboration. This was a follow up to the visit last November to BGI and the Chinese Gene bank in Shenzhen. Our visitors met research leaders at the Institute for Genetics and Molecular Medicine and then attended a one-day sandpit with 35 Edinburgh researchers to define and interrogate the 'grand challenges' and brainstorm collaborative solutions. For many, a 'slide-free day' was something of a novelty, but there was some enthusiastic participation which lead to many ambitious and imaginative ideas no doubt assisted by the wonderful Edinburgh skyline

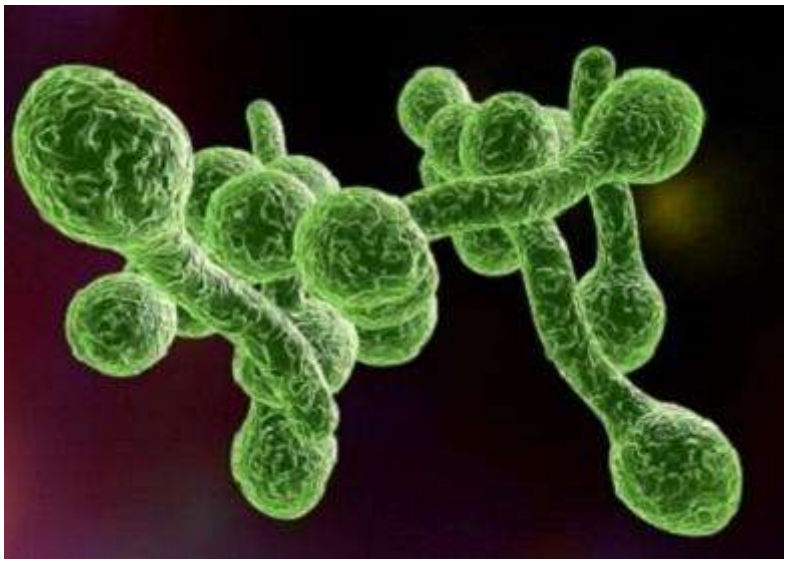
views from the roof top venue views and some Tunnocks caramel wafers. The day was seamlessly facilitated by Alison Gray from Skillfluence.

We are looking forward to further developing our overseas links by leveraging GCRF funding and working in close collaboration with our partner UK Synbio Centres.

Our Chinese guests enjoyed views from Edinburgh Castle after a whisky tasking experience.

Five synthetic yeast chromosomes built

Submitted by synbio on Fri, 03/10/2017 - 08:01



A significant new milestone in the Synthetic Yeast Chromosome project has been reached with five yeast chromosomes now fully constructed. The development could have widespread benefits for improved understanding of fundamental biology as well as food security, healthcare and biofuels.

A large team of researchers has been working for some years to painstakingly rebuild the 16 chromosomes of yeast, one of our most hardworking industrial microbes. In what is a truly global initiative, scientists from the UK, USA, China and France have been stitching together the fragments of code to create a synthetic yeast genome.

Dr Patrick Cai, a Chancellor's Fellow at the University and a group leader in the Centre for Synthetic and Systems Biology, has been collaborating with BGI-Shenzhen in China to construct the yeast chromosome known as SYNII – one of the largest in yeast. The Edinburgh team also contributed to building a further four chromosomes, in addition to taking part in two studies detailing their design and analysis. The research has shed light on various aspects of yeast's behaviour, and shows how it can be completely functional with synthetic genetic codes. This is a significant step towards construction of the first eukaryotic genome and a technical tour de force.

The project has been supported by the Biotechnology and Biological Sciences Research Council and the seven papers outlining the construction are published concurrently in the journal *Science*.

Microsoft and Edinburgh to make biological computation a reality

Submitted by synbio on Wed, 03/08/2017 - 16:38

Microsoft has teamed up with SynthSys Principal Investigator, Dr Baojun Wang, to build the genetic 'hardware' needed to turn living cells into biological computers.

In your everyday laptop or tablet, computations are made of binary calculations executed by electrons flowing through metal wires connecting multi-layered logic gates. Similarly, cells are akin to living computers but have biochemical inputs and outputs, and internal gene networks that mimic the logic gates needed to integrate multiple environmental and cellular signals. As with the design of silicon-based electronic circuitry, customised genetic circuits can be constructed to link the various sensors and outputs and to program cells to generate desired behaviours in response to specific signalling inputs.

As part of this effort, Microsoft is funding a graduate student in Baojun's lab to engineer and compile a library of versatile orthogonal (i.e. those that won't cross-react with the cell's native genetic components) genetic building blocks. These will then be used to program advanced signal processing capabilities in live bacterial cells – something that to date has proven very challenging.

Microsoft is providing bespoke software tools and cutting edge modelling expertise to the team realising its ambition to design a biological computer that could contain dozens or hundreds of biological computing blocks.

Dr Neil Dalchau, of the Biological Computation group at Microsoft Research Cambridge, says: "This strategic partnership will combine our strengths in computational modelling and Edinburgh's expertise in synthetic biology to push the frontier of biocomputation, scaling up the presently limited computational capacity of biological machines. The resulting benefits could be enormous with applications as varied as tools for *in vivo* diagnosis and treatment of diseases, and enhancing high-value biomolecule production in microbial bioreactors."

Microsoft are funding a graduate student in the Wang lab under the Microsoft Research PhD Scholarship Program, which supports EPSRC iCASE awards.

Photo: Copyright Microsoft Research

Exploring Grand Challenges in Uganda

Submitted by synbio on Tue, 03/07/2017 - 16:25

On February 8-10, Prof Susan Rosser, Prof Alistair Elfick and Dr Liz Fletcher attended the AGM of the **MUII-Plus DELTAS** programme held in Entebbe, Uganda, at the Uganda Virus Research Institute.

The MUII-Plus programme is well established and is directed largely to exploring the aetiology and pathology of infectious diseases pertinent to Sub Saharan Africa. The research initiative is funded by the Wellcome Trust, UK Aid and NEPAD and its long-term vision is to train African leaders in bioinformatics, immunity and infectious diseases, which it is doing admirably well.

Over three days, the Edinburgh team got a great insight of endemic diseases such as parasitic infections (*Schistosomiasis*, *Trypanosomiasis*), tuberculosis and HIV, which continue to be the source of major sources of ill health in Uganda and Sub-Saharan Africa (SSA) more widely. An analysis of the ongoing research and areas of unmet needs will follow.

On the first day of the event, the Centre team presented to >50 delegates on what synthetic biology was and the many opportunities to deploy it towards research challenges for infection and immunity. This was certainly a new area of research to most individuals in the room, many of them quite taken (if not amazed!) at the potential opportunities arising. Several discussions have arisen about applications for synthetic biology, including potential collaborative projects with UK-based researchers who had also attended the event.

We later ran a workshop, facilitated by Alison Gray (Skillfluence) on ‘Creative Problem Solving’ bringing together 25 senior managers and researchers from the University of Makerere and local hospital for a brainstorm. There was plenty of chatter, a lot of post-it notes, and some very interesting and revealing insights into the challenges faced by local scientists and health professionals. Those attending were handsomely rewarded with a Scottish delicacy - a Tunnocks caramel wafer - which had miraculously survived the 30 degree heat.

We are very grateful to Professor Allison Elliot, MUII-Plus Director, and her team for the invitation and the very warm reception that they provided.

The trip and workshop was funded through a BBSRC Global Challenge Research Fund award to Professor Susan Rosser.

Photo: Hard at work brainstorming solutions for grand challenges.

Inside the Black Box: Heterogeneity, modelling and healthcare

Submitted by synbio on Tue, 03/07/2017 - 11:41

Luis Montano, a Wellcome Trust funded PhD student in the lab of Professor Peter Swain, developed an interactive exhibit for the Future Health Hackathon in Edinburgh. Here he explains the thinking behind the exhibit.

Since I joined Peter Swain's lab, the idea that genetically identical cells comprise a heterogeneous population of decision makers really stuck with me; particularly in how biochemical networks would be able to drive such heterogeneity. For example, for clinicians and patients, tumour heterogeneity means uncertainty during diagnosis, or even hopelessness. However, for a systems biologist, the mechanisms controlling such heterogeneity are an exciting enigma – that's the 'black box'. While some people might find black boxes too uncertain to handle, some of us find them eerily interesting.

What biologists have done for decades is break these black boxes open and figure out the function of each component. Another way to understand how these systems work is by providing many inputs and reading many outputs. You can then use the information to build a mathematical model where we hypothesise the circuitry connecting the two. Engineers and physicists have known this for a long while, and the use of such information to elucidate biological systems is becoming common in systems biology.

But for your 10-year old niece, this is a lot to take in.

For the data-X Initiative, my collaborator Bodhan Mykhaylyk and I wanted to convey the mystery and relevance of the black-box problems to a lay audience. Crucial to this was to attach the silver lining – that we have the mathematical and informatics tools to address this complexity. As an example that people could relate to, we decided on how different patients' responses to treatment could vary starkly.

We developed a 'patient simulator' in which players could administer the treatment (input) in real time to an infection. But for every gameplay, the infection would have slightly different properties. Players would have to decide on a tailored treatment route every time. The infection's output is displayed on a dummy, with light of different colours indicating the infection and the treatment.

Inside the patient simulator is a Raspberry PI (essentially a mini computer). Python code in the PI sends the controller input to an LED output. An Ordinary Differential Equation (ODE) model drives the connection. In it, there are parameters for bacterial reproduction, natural antibiotic degradation/dilution, the antibiotic's killing efficiency and whether the bacteria can inactivate the antibiotic (as in beta-lactam antibiotic resistance). For every game, random sets of parameters are chosen, such that the player never knows at start what the system is, or how the system will respond. For some of them, strikingly high levels of treatment would actually work; for more chronic infections, a temporal pattern of treatment ('a course of treatment') would be most effective to keep the patient healthy.

For a system this simple, patient heterogeneity was wide enough to impress the public. Little kids learned the rules of the game quickly, and showed an addictive perseverance in trying to cure the patients. They also quickly spotted which 'patients' would be untreatable by the methods provided. While adults asked the most questions, the installation had the strongest effect on people who had a personal history with infection. One lady had recently contracted pneumonia which had hospitalised for 6 months because of her doctor's failure to find the best treatment quickly. For such individuals, the value of simulation in indentifying effective threapy was obvious: If doctors could find found out quickly what they were dealing with, NHS time and resources NHS, let alone the personal cost to the patient, could be reduced. The exhibit also allowed people to learn about the relevance of antibiotic courses and not self-medicating. And overall, the light display and unpredictability seem to keep people interested for long enough to explain the science.

Even though this model was relatively simple, I decided to keep all the input-output data generated by the players. Equally, if we could collect data from thousands of simulations, for thousands of models, could we put this to good use? Can we answer some interesting questions: a.) Given the observed response, can we infer whether the infection is antibiotic resistant? b.) For real infections for which models exist, can we find optimal treatments by looking at the performance of hundreds of players? c.) Regardless of what the underlying infection is, can any of the models provide good explanatory power for some real life infections? and d.) Can we train doctors by letting them hypothesise different patient scenarios through a similar game?

Whether any of these become a reality or not, 'Inside the black box' is at least doing its job - starting a conversation about the power of modelling, simulation and data analysis to improve our lives. The installation was recently invited to a healthcare product development Hackathon organised by Edinburgh-based Product Forge, where it received the attention of NHS officials.

If you would like to find out more about the Black Box, please contact Luis Montano

Engineering eco-evolutionary feedbacks with synbio

Submitted by synbio on Tue, 02/14/2017 - 08:52

Cells can cooperate and cheat and researches at SynthSys have shown that synthetic biology can be used to test novel hypothesis on the way cellular cooperation is preserved.

Cells must cooperate to survive all sorts of ecological and environmental stresses. Cooperation is always at risk of cellular cheaters (so-called free-riders): they can profit from cooperative cells, avoid any contribution to the community, and ultimately lead to its collapse. However, contrary to what one may think, the collapse caused by the cheaters may have its own beneficial ecological effects; it facilitates cooperative cells to group together, a phenomenon that finally allows the resurgence of cooperation and of the entire population. Dr Matteo Cavaliere, from SynthSys and the School of Informatics, and colleagues obtained this paradoxical finding by combining computational modelling and wet-lab experiments with synthetic cells that have been engineered with the ability to cooperate and cheat. The results show how synthetic biology can be used to engineer and study the interplay of ecology and evolution, an issue that can crucially affect the resilience of cellular communities. The team plan to extend this work to mammalian systems in collaboration with members of the UK Centre for Mammalian Synthetic Biology.

The work was published in Nature Scientific Reports. http://www.nature.com/articles/srep42561

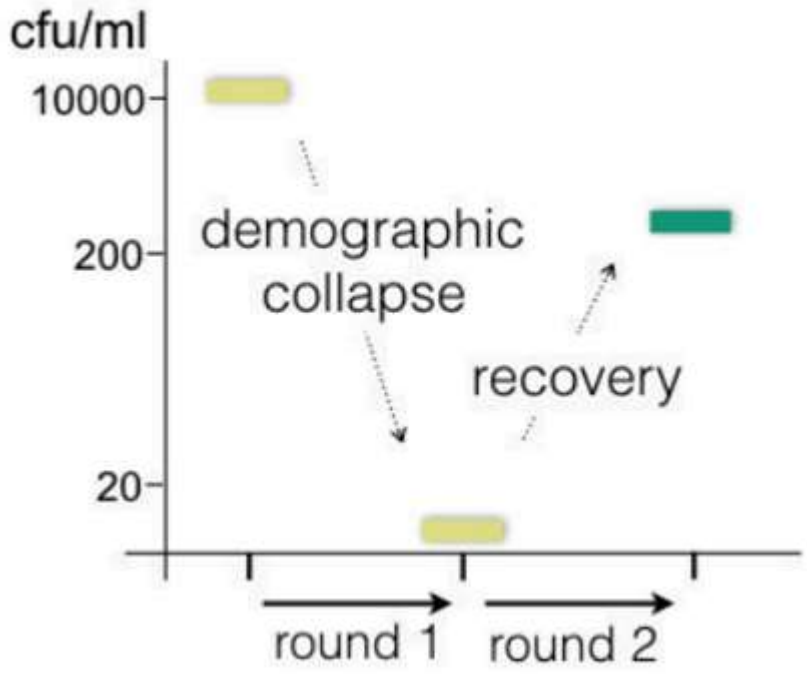


Figure: Population collapse induced by cheating cells and following recovery facilitated by an engineered eco-evo

Award to enable scale-up of valuable blue dye

Submitted by synbio on Wed, 02/01/2017 - 13:33

The ability to mass produce a high-value natural blue dye for use in the food, pharmaceutical and other industries is being developed with help from SynthSys researchers, Drs Baojun Wang and Alistair McCormick, in a partnership with Scottish Bioenergy.

The team will work on scaling the ability to produce large quantities of a blue pigment-protein, called C-phycocyanin (C-PC), which is derived from spirulina algae and is the preferred source of natural blue colourant for industry. It is sought after to replace artificial colourants like Brilliant Blue, which are unpopular with consumers and have led global brands to commit to removing all artificial colourants from their products. Global demand for natural blue dye is expected to increase ten-fold in the next two years from the food industry alone, to a market worth about £350 million.

A £200,000 award from the Industrial Biotechnology Innovation Centre (IBioIC) will boost a research partnership between the industrial biotech company Scottish Bioenergy and SynthSys researchers to develop a large-scale process to extract C-PC from the spirulina. Natural blue dyes are challenging to create as there are few sources of blue pigment in the natural world, and formulations are difficult and expensive to create in large quantities.

Scottish Bioenergy, which specialises in commercial production of C-PC, has been working with experts in the University's School of Biological Sciences on collaborative projects since 2012. The partnership has been accelerated by ongoing support from Edinburgh Research & Innovation (ERI), the University's commercialisation and industry engagement arm.

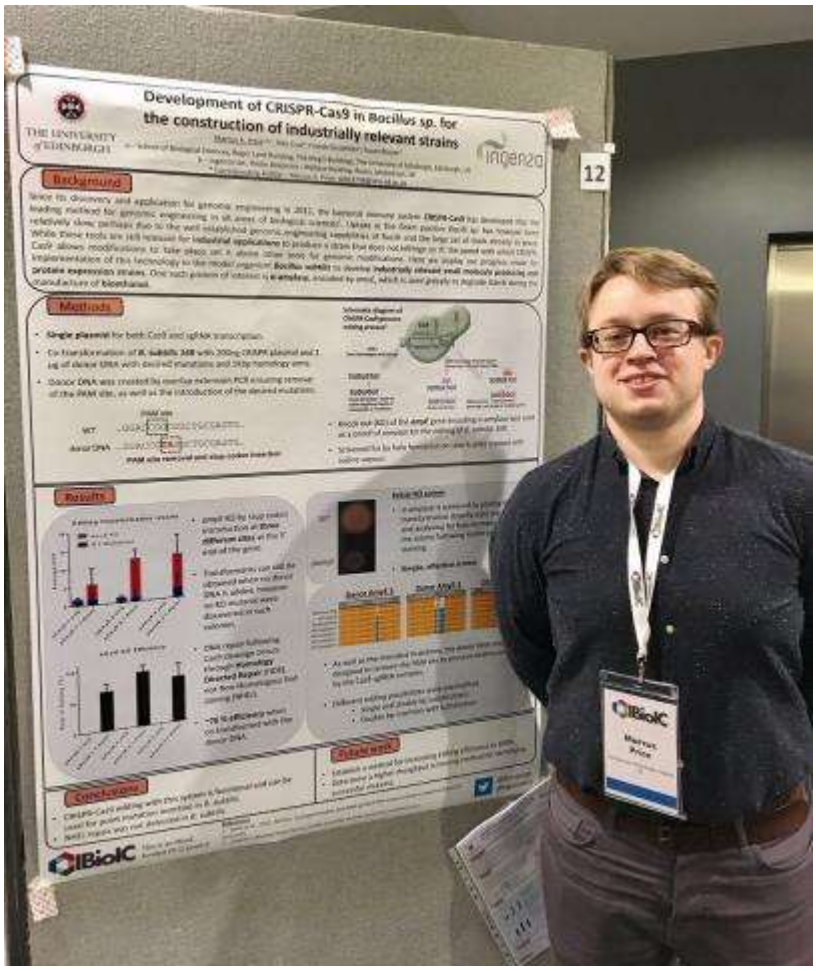
The company has recently overcome important technical obstacles and challenges linked to the scale of production.

In this latest project, funded by IBioIC's Micro Accelerator Programme, the team will identify and optimise techniques for extracting the pigment protein, and to develop economically feasible methods for producing large volumes of C-PC. They will also engineer strains of bacteria to produce high yield and high purity C-PC.

Image: Spirulina (dietary supplement) powder made from cyanobacteria genus Arthrospira, credit Music4TheKids CC-BY-SA-3.0

Delivering Impact with Industrial Biotech: Conference 2017

Submitted by synbio on Mon, 01/30/2017 - 11:55



Ambitiously entitled 'Delivering Impact', the third Annual Conference of the Industrial Biotech Innovation Centre (IBioIC) attracted over 400 delegates over two days in late January. It didn't disappoint and the energy felt is testament to both the success of the Innovation Centre and the extent to which Industrial Biotechnology (IB) is firmly on the agenda for industry, academia and public and private investors. SynthSys sponsored an exhibition stand at the conference to further raise the profile of IB-related synthetic biology research in Edinburgh.

There is no pithy definition for industrial biotechnology and no high-profile champion (aka Ellen Macarthur or Brian Cox), a good point raised by one delegate. Nevertheless companies are chasing products and services to deliver to the market. You'll be familiar with the drivers for the IB market: a growing global population demanding more food, energy and products and in the process creating more waste. IB offers solutions for improved productivity, minimizing waste in the process and even using waste streams as feedstock for new products. There were lots of examples at the conference including using methane as a

feedstock for protein for animal feed, high value oils from seaweed, metabolic engineering of yeast to produce high value chemicals, or 'recycling' food waste for energy.

The IBioIC has been helping bring the best of Scotland's research together with our innovative start-ups and major multinationals, to build a community of IB innovators, practitioners, translators, end users and investors to put Scotland on the map for IB. To date the IBioIC has funded a total of 38 projects, trained tens of MSc students and PhD students and established two equipment centres (Rapid Bioprocess Centre and Flexible Downstream Bioprocessing Centre). Recently the BBSRC awarded IBioIC a £2.6M Collaborative Training Partnership, which will fundan additional 27 PhD students over the coming 5 years.

To date, SynthSys and the UK Centre for Mammalian Synthetic Biology has greatly benefited from IBioIC funding calls with successful awards for industry-led projects such as Susan Rosser's project with Unilever to accelerate bacterial production of saponins, and Patrick Cai's yeast metabolic engineering project with DNA supplier Twist Bioscience. The University now has a large community of researchers actively engaged or interested in IB research.

But what is the future for industrial biotechnology with the ever shifting sands of our Brexit, Indyref#2, 'post-truth' Trump world? The good news is that it appears to be firmly on the funding agenda. IB and synthetic biology are outlined in the UK Government's Industrial Strategy 'Green Paper' (read here http://bit.ly/2jMKGFw) and in recent stakeholder discussions around the Industry Challenge Fund recently announced by Theresa May.

[If you are interested in what was discussed at the consultation meetings read more here https://ktn-uk.co.uk/articles/industrial-strategy-challenge-fund-engagem...

Special congratulations go to Marcus Price for winning a prize for the best PhD poster for his research on Crispr-Cas 9 of Bacillus in the Rosser Lab in collaboration with Ingenza.

Engineering Rubisco to increase plant productivity

Submitted by synbio on Mon, 01/23/2017 - 12:56

Generating new crop varieties with increased yields is critical for safeguarding future food security. One of the key limiting factors for productivity is the poor efficiency of the photosynthetic enzyme, Rubisco, which is responsible for net CO_2 uptake in all plants.

Compared to other enzymes, Rubisco has a slow turnover rate and a relatively low affinity for CO_2. Rubisco also catalyses a competitive side-reaction with O_2, leading to an energy wasteful process called photorespiration. Many photosynthetic algae avoid photorespiration by using a highly efficient CO_2-concentrating mechanism (CCM) that concentrates CO_2 and Rubisco to a subcellular micro-compartment called the pyrenoid, where Rubisco operates more efficiently.

A recent publication from the research team led by Dr Alistair McCormick highlights their continued efforts to introduce the algal CCM into higher plants. In this work, Rubisco was modified in the model plant *Arabidopsis thaliana* by introducing the subunits required for pyrenoid assembly from the green alga *Chlamydomonas reinhardtii*. The hybrid Rubisco was catalytically similar to the plant native form, demonstrating that it is possible to assemble a stable and functional 'pyrenoid competent' Rubisco in higher plants. The team has now generated plant lines that are suitable for further introduction of other pyrenoid formation factors. This opens up new possibilities to enhance Rubisco efficiency in plants and to potentially increase agricultural productivity.

Further reading: Atkinson et al. 2017. Rubisco small subunits from the unicellular green alga *Chlamydomonas* complement Rubisco-deficient mutants of *Arabidopsis*. *New Phytologist.* DOI: 10.1111/nph.14414

Optical density: the risks of making assumptions

Submitted by synbio on Wed, 01/11/2017 - 10:47

With the surge of interest in antimicrobial resistance, microbial synthetic biology and biotechnology applications, optical density measurements - the standard way to estimate cell numbers in microbiology - are rapidly becoming automated and high throughput.

However, many microbiologists are unaware of when the underlying assumption that optical density measurements are proportional to cell numbers is actually true. In a recent paper[1], the Swain and Pilizota labs provide data on the dependency of optical density on factors such as cell size, refractive index, and culture heterogeneity for both *E. coli* and *S. cerevisae.* The interpretation of these data, as well as how calibration is best performed is discussed, particularly for high throughput approaches.

In related work[2], the two labs have also introduced a non-parametric method to infer first and second time-derivatives as a function of time from time-series data. The approach is based on Gaussian processes and applies to a wide range of data, including growth rates of microbial cells.

A user friendly GUI is available at: http://swainlab.bio.ed.ac.uk/software/fitderiv/

We encourage readers to try the software: the method offers several advantages over existing methods to estimate growth rates. We would also greatly appreciate any comments about the GUI, both in terms of potential problems (no matter how small) and any suggestions for improvements.

References

1. Stevenson K, McVey AF, Clark IB, Swain PS, Pilizota T. General calibration of microbial growth in microplate readers. *Sci Rep*. 2016;6:38828

2. Swain PS, Stevenson K, Leary A, Montano-Gutierrez LF, Clark IB, Vogel J, Pilizota T. Inferring time derivatives including cell growth rates using Gaussian processes. *Nat Commun*. 2016;7:13766