

Integrated Biorefining Research and Technology Club (IBTI Club)

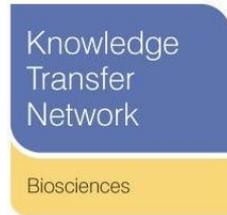
Workshop to promote the 2nd call for
research proposals

23 September 2009

Broadway House
Tothill Street
London SW1H 9NQ



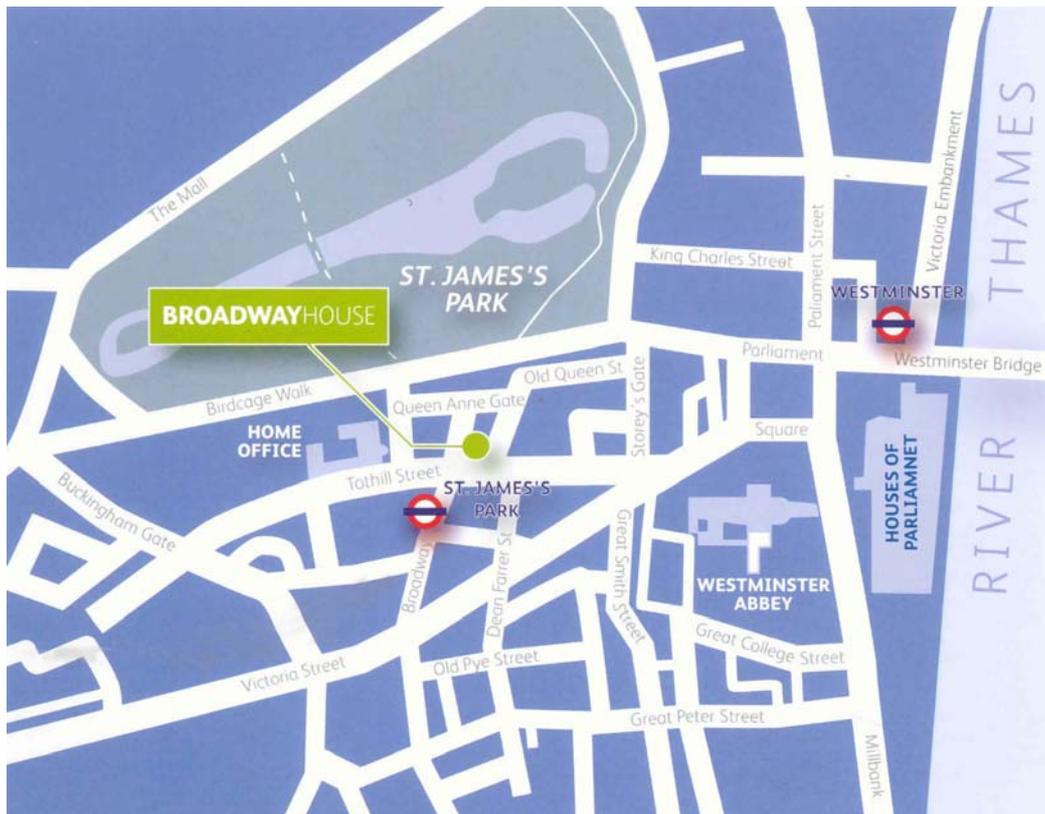
IBTI • INTEGRATED BIOREFINING RESEARCH AND TECHNOLOGY CLUB



DIRECTIONS TO BROADWAY HOUSE

Broadway House is close to both Waterloo and Victoria mainline train stations and opposite St James's Park underground station. Nearby there are several hotels with ample accommodation and NCP car parking is available locally.

<http://www.broadwayhouse.info/conference-venue.htm>



CONTENTS

Workshop Programme	9
Workshop Aims	11
Background to the IBTI Club	12
Scope of Second Call	14
IBTI Club Funded Grants	20
IBTI Club Members and Company Information	23
Delegate List	28
Office Contacts	33

WORKSHOP PROGRAMME

23 September 2009 • Broadway House, London

Registration

10:00am

Introductory Presentations

Council Chamber

10:30 – 10:40 Welcome and Introduction
Peter Fryer, IBTI Club Steering Group Chair, BBSRC Council

10:40 – 11:00 Overview of research challenges
Christopher Knowles, IBTI Club Academic Coordinator

Coffee Break

Caxton Room

11:00 – 11:30

Research Challenges from an Industrial Perspective

Council Chamber

11:30 – 11:50 Kirstin Eley, TMO Renewables

11:50 – 12:10 Surinder Chahal, Croda

12:10 – 12:30 Tom Jenkins, IBTI Club Industrial Coordinator

12:30 – 13:00 Question time
Panel: Peter Fryer (Chair)
Chris Knowles
Kirstin Eley
Surinder Chahal
Tom Jenkins

Lunch and Networking

Caxton Room

13:00 – 14:00

Surgery Sessions

Boardroom / Brunel Room / St James' Room

14:00 – 16:00

Surgery sessions will provide a forum for project ideas to be put to the Steering Group and Club members and to get advice and feedback before submitting an application. These meetings will last for 15 minutes and will be held in strict confidence. The meetings will be based on appointments made prior to the meeting. During this session there will also be the opportunity for one-to-one meetings with other delegates who you may wish to meet.

Meeting Close

16:00

AIMS

The overall aim of this workshop is to promote the second call for research proposals from the Integrated Biorefining Research and Technology Club (IBTI Club). The workshop is targeted at researchers and will outline the second call for proposals to the IBTI Club, the research challenges to be addressed and provide an industrial context to these challenges.

Networking

There will be opportunities for networking and you should take the opportunity to make new contacts and exchange ideas with the potential of forming new collaborations for applications to the IBTI Club. BBSRC staff and Club Coordinators will be available throughout the day to answer any questions you may have regarding the IBTI Club.

Question Time

There is a session of the workshop scheduled as “Question Time” and you will have the opportunity to question members of the Steering Group and BBSRC about the IBTI Club. The Question Time Panel members are:

Peter Fryer – IBTI Club Steering Group Chair, BBSRC Council

Chris Knowles – IBTI Club Academic Coordinator, Oxford Innovation

Kirstin Eley – TMO Renewables

Surinder Chahal – Croda

Tom Jenkins – IBTI Club Industrial Coordinator, Biosciences KTN

Surgery Sessions

Confidential surgery sessions will be available where you can discuss potential outline applications with a small number of IBTI Club Steering Group and Industry Club members who will be able to advise you on the relevance of your application to the Club's aims. All proceedings of these meetings will remain in confidence. If you have not previously booked a surgery session and would like one, please contact Kristine Cherry (kristine.cherry@bbsrc.ac.uk) to see if one can be made available.

BACKGROUND TO THE INTEGRATED BIOREFINING RESEARCH & TECHNOLOGY CLUB (IBTI CLUB)

Biorefining can be defined as the fractionation and processing of renewable biomass feedstocks for industrial applications. Drawing parallels with refining fossil oils, biorefineries will have to be highly efficient, produce minimal waste streams and allow the fractionation of raw materials and recovery of multiple products. Ideally they will be able to produce as wide a range of bulk and high value chemical products as is currently available from petrochemical feedstocks. In terms of bulk supply, these feedstocks will be primarily derived from terrestrial and aquatic plants, as these are responsible for photosynthetic primary productivity and carbon fixation.

The development of biorefining into commercially viable and sustainable industrial processes is clearly a major undertaking, which will require interdisciplinary research encompassing the biological and physical sciences interface. With this in mind, three science themes have been identified for the IBTI Club.

- **Optimisation of feedstock composition**
- **Integrative bioprocessing**
- **Enhancing product value**

While it is recognised the current focus on biorefining is as an adjunct to biofuel production, the diversity of products derived from renewables could radically change this paradigm in the near future. The initiative therefore takes a broad view as to the types of desirable outputs obtainable from biorefining. For example the following products have all been identified as potentially useful outputs of future refining processes:

- Speciality oils varying in carbon chain length, desaturation and substitution
- Surfactants
- Polymers, oligomers and their monomeric precursors
- Heteroaromatic and pseudoaromatic compounds
- Flavours and nutraceuticals
- Terpenoids
- Cosmeceuticals, essential oils, vitamins
- Phytopharmaceuticals
- High-value chiral intermediates and products

While this list is not exhaustive it does illustrate the broadness in scope of the initiative.

Optimisation of feedstock composition

Plant and algal biomass are heterogeneous materials from which a range of products may be derived by extraction and conversion. Sustainable biorefining requires that value be obtained from as much of the biomass as possible and while this requires efficient extraction and conversion technologies, it is also important that feedstock quality is optimised. Traits to be developed include increasing the yield of valuable components and the ease with which these components can be extracted and processed. Plant materials to be targeted include biomass crops, or agricultural residues, for use in the bulk production of biochemicals and materials such as sugars, oils, fibres, liquid fuels or biogas. In addition, the application of biorefining will mean a range of high value products (speciality fine chemicals, bioactive compounds) are also potentially recoverable as minority by-products from plant or algal feedstocks. The range and quantity of both bulk and speciality products will be extended by manipulating the metabolism of feedstock plants through marker-assisted breeding, genetic engineering or a combination of both.

Integrative bioprocessing

Biorefining will require the development of more efficient and intense microbial bioprocesses, which can be integrated both with separation technologies and with chemical transformations. In addition, significant advances in the associated engineering and scale-up will be required. The great advantage of microbial processes is the ability to resolve most of the available carbon sources and substrates in complex feedstocks to relatively small numbers of synthetically useful building blocks. Therefore, one of the most important targets for the potential user community will be met from studies which seek to promote a high degree of substrate utilization from a real or artificially constituted biorefinery feedstock, with specific substrate consumption rates, as important engineering targets. These improvements at the microbial level must be matched by the design of simple and effective product recovery and purification processes such that the added value of chemical building blocks produced can be captured.

Resolution of the bottlenecks in this area of bioprocessing will require research at the interface between chemistry, engineering, microbial fermentation, enzymology and the physical barriers to biological processes, and research projects are expected to be multidisciplinary.

Enhancing product value

While it will be possible to directly tailor many products from biorefining for subsequent use in industrial applications, it is also recognised that major by-products may be of limited economic value. The processing of these bulk by-products into new higher value chemical entities with wider applications is an immediate challenge for the successful implementation of biorefining. Areas of interest include the use of novel chemical and bioprocessing as well as fractionation methods to recover high-value products.

Allied to biofuel production, a topical example is the recovery of useful molecules from ethanol fermentation residues. This represents a considerable biological and chemical challenge with the residues composed primarily of lignin, which is highly recalcitrant to biological conversion to useful monomeric species. Finding the way to control the decomposition of lignin could provide a future renewable source of small aromatic units. Alternatively, unlocking the industrially useful organic entities in these polymers will require the development of enzyme and chemically mediated free-radical reactions to open the aromatic rings to yield molecules that can be used as fermentation feedstocks. Similarly, in other industries such as sugar refining and paper production current by-product streams contain potentially useful chemical feedstocks. Unlocking the economic potential of these chemical intermediates requires specific bioprocessing and/or chemical conversion. In an alternative strategy, the biotransformation of low-value products into fine chemicals by retaining synthetically useful functionality represents a further mechanism for adding value to biorefining.

Currently supported research

The first call for research proposals from the IBTI Club provided support for four research projects totalling £1.8M. Summaries of the projects supported through the first call can be found on the web here: www.bbsrc.ac.uk/ibticlub.

THEMES FOR THE SECOND CALL FOR RESEARCH PROPOSALS SUPPORTED BY THE IBTI CLUB

Grant applications are invited for the second call of the IBTI Club. The closing date for applications is 5 November 2009. There is a two stage application procedure. Initially, proposals must be submitted on the Outline Application form. Approximately £3M is available for grant awards in this round. The funding is from a common pot with contributions from the BBSRC, EPSRC and Industry. Further details on specific guidelines for the call are in Annex 1.

All applications must focus on the research themes of the IBTI Club (i.e. optimising feedstock composition, integrative bioprocessing, enhancing product value). The call should be of interest to scientists with either a biological (e.g. plant science, biochemistry/enzymology, microbiology) or physical (e.g. chemistry, engineering, separations technology) science background.

Feasibility studies (with a maximum of one year's funding) and standard grant applications of up to a maximum of five years' funding are invited. There are insufficient funds to support major programme grants from large consortia, therefore we envisage funding smaller multidisciplinary approaches. It is recognised that applicants may need extra skills and expertise, and applications from researchers exhibiting complementary skills are particularly welcomed. It is possible that individual applicants may not be able to identify particular partners with specific expertise in advance of submission of the outline applications. In such cases, this should be indicated on the application form. Partnerships and consortia may be built after the outline stage and through other IBTI Club activities. Developing a UK biorefinery community composed from both academia and industry is part of the aims of the club.

Proposals in this round should not focus on biofuels as the primary output of the application, rather proposals that enhance biofuel processes are of interest, including improved production of platform chemicals, added-value products and biomaterials, although it is recognised that in biorefineries that biofuels are usually the primary product.

Applications should refer to the schematic diagram of a biorefinery process given with this call (see Annex 2). The applications must highlight how the proposed research will fit into the biorefinery process, and how the outcomes will enhance product generation, process intensification, productivity or process simplification, resource and energy minimisation, minimisation of carbon footprint, etc. Robustness, adaptability and flexibility are also important considerations. Applicants may suggest alternative flow paths for a biorefinery. **An integrated approach to projects is important, including multidisciplinary approaches and integration across processes**, though it should be borne in mind that integrated projects do not have to tackle the whole biorefining process.

As relevant, the applicants need to indicate the type(s) of feedstock(s) that can be used in their proposed system, the applicability to UK based or more international biorefineries, and the degree of flexibility in terms of substrate acceptability and in the operation of the biorefinery plant. In addition, where possible, the environmental sustainability and CO₂ minimisation/capture should be indicated.

Priority Topics

The topics for which grant applications are invited in this round are based on feedback from the first call and the resulting recommendations of a recent IBTI consultation exercise, designed to discover the grand challenges for biorefinery development and the hurdles that must be overcome. These topics are of interest to industrialists within the Club, based on their analysis of market needs. Examples of science areas relevant to the second call could include:

1. Feedstocks: Engineering of multiple or single feedstocks

2. Upstream Processing: Separation and fractionation of components, water removal, lignocellulose degradation including biotreatments, and separation of lignin, feedstock handling, other methodologies for treatment of feedstocks
3. Bioprocesses: Enhanced fermentation (including anaerobic digestion) and chemical processes, better understanding of microbial consortia for feedstock degradation and product generation, rapid bioprocess design and scale-up
4. Downstream Processing: How can all/most components of the feedstock be utilised? Separation of products, water removal and recycling, optimisation of product recovery, by-product recovery and utilisation
5. Product Formation: Can new products be identified and formed? Novel pathways to established or new products, enhanced yields of known platform and higher value products, links to end-user requirements
6. Process Integration: How can processes be integrated efficiently in a biorefinery? Integration across and at the interfaces of engineering, chemical and biological sciences

Other Important Considerations

- Skills and Training: Biorefineries will require interdisciplinary skills in biology, chemistry and engineering, therefore grant applications must clearly indicate the skills and training elements of the project.
- Economics: For biorefineries to be feasible, the technology must be scalable and economically viable, and applicants are expected to demonstrate the feasibility of their projects from this perspective.
- Social and Environmental Considerations: New technologies for biorefining must be socially and environmentally acceptable and sustainable. Tools like life cycle analysis could be applied to assess the environmental impact of new processes and products.

At the Outline stage, applicants should be clear on how they will address these issues in the Full Application stage. As applicable, full grant applications will be required to indicate that the research outcomes fit these criteria.

Grant applicants may, if they so wish, consult the Academic Coordinator of the IBTI Club, Professor Christopher Knowles (chrisjknowles@btinternet.com), about the application process.

GUIDELINES FOR CALL

- The objectives of the proposed research must fit with the scientific challenges detailed in this document and the science proposed must fall within the remit of BBSRC and EPSRC.
- Outline proposals must be submitted in the first instance.
- Research proposals are sought for feasibility studies (with a maximum of one year's funding) and standard grant applications of up to a maximum of five year's funding.
- There are insufficient funds to support major programme grants from large consortia, therefore we envisage funding smaller multidisciplinary approaches. It is recognised that applicants may need extra skills and expertise, and applications from researchers exhibiting complementary skills are particularly welcomed.

CRITERIA FOR ASSESSMENT

The primary criteria for assessment are the quality of science proposed and the strategic relevance to the IBTI Club. It is expected that any proposal that goes on to be funded through the Club will be competitive against comparable international work and will demonstrate alignment with the Club's aims. Proposals will be assessed against the following criteria:

- **Scientific Excellence**
The extent to which the proposal meets the highest international standards of current research in its field. High performance against this factor will indicate a project of the highest standard, competitive with the best activity anywhere in the world, demonstrating originality and innovative potential.
- **Strategic Relevance to the IBTI Club**
Demonstrated alignment with science themes and priority topics, relevance to the biorefining industrial sector, and balance of overall Club research portfolio.
- **Economic and Social Impact**
The extent to which the output of the research will contribute knowledge that shows direct potential for economic return or societal benefits to the UK.
- **Timeliness and Promise**
The extent to which the proposal is particularly appropriate at the present time, or offers longer-term benefits over and above the direct value of the research.
- **Cost Effectiveness**
The extent to which the resources requested, relative to the anticipated scientific gains, represent an attractive investment of BBSRC funds.
- **Staff Training Potential of the Project**
Where resources are requested for postdoctoral or other research staff, please comment on the extent to which the proposed project will provide research training and development opportunities of benefit both to the individual(s) employed, and to the wider science base beyond the completion of the specific project.

SPECIAL CONDITIONS

Recognising the financial support for the programme from industrial members of the Club, it should be noted that special conditions will be attached to any research grants from the IBTI Club. A letter from the institution's technology transfer office or equivalent, acknowledging that the institution is able to accept those conditions relating to IP, will be requested at the full application stage. The conditions are as follows:

Early Access

Commercial parties are entitled to early access to results from research funded by the Club. To ensure this grant holders must:

- Give at least 28 days notice of an intention to publish, outside of the Club, results from research funded by a Club grant. The material for proposed publication should be submitted to the Industrial Liason Coordinator along with the notice of intent to publish. The Coordinator will distribute a copy of the same to each of the Commercial Parties who shall have fourteen (14) days from receipt of such copy to inform the Coordinator if in their view the proposed publication may
 - (i) dilute or prejudice the value of proprietary information of a Commercial Party or
 - (ii) jeopardise the application for Resulting IPR protection or
 - (iii) otherwise inhibit future exploitation of the results and whether a Commercial Party has an interest in exploiting those results.
- Produce annual progress reports. A form will be available on the IBTI Club website for Grant Holder to complete and Grant Holder will be notified in advance when the final report will be due.
- Attend and present the results and progress of Club funded research at 6-monthly Club Dissemination Events. Grant holder will be notified of the dates and format of their presentation.
- Give advance notification of any opportunities to exploit intellectual property arising from their grant to the Commercial Parties.

Access to Resulting IPR

Commercial Parties are entitled, if they wish, to engage in good faith negotiations with the Research Organisation for terms of access to the Resulting IPR to allow further development or commercial exploitation of results, such access rights preferably to include the right to sublicense. This must be offered before access to Resulting IPR can be offered to third parties outside the Club. An interested Commercial Party can exercise its option right by giving notice to the Grant Holder within one month of the date of receipt of notice of Results or Resulting IPR.

Good Faith Negotiations

Good faith negotiations would imply a willingness to reach agreement with Commercial Parties on the terms and conditions of a commercial licence, to desist from publishing the Results or making offers to third parties while negotiation with Commercial Parties are ongoing and, if such agreement is not reached within a reasonable period (for example four months from the exercise of the option) that the Research Organisation would not seek to enter into negotiations with third parties on terms substantially more favourable to such third parties.

APPLICATIONS PROCEDURE

There is a 2-stage application process:

- Outline Applications will be submitted through Je-S. The closing date for outline applications is **5 November 2009, 4pm**.
- Successful applicants will be invited to write a full application in December 2009 for submission by February 2010 (dates to be confirmed).

- Impact statements will be required for grant applications that are selected for the second stage, full grant applications, and should be formulated to meet the needs of biorefinery processes. A workshop for applicants successful in the Outline stage will be held in January 2010 to facilitate collaborations and explain requirements for impact statements.

ASSESSMENT

Outline applications will be assessed by the IBTI Club Steering Group and will not be externally reviewed. Full applications will be externally peer reviewed prior to final assessment by the IBTI Club Steering Group. The decision to fund full applications will be announced in May 2010. Further details on assessment are as follows:

- The criteria of scientific excellence and strategic relevance are given equal weight in the assessment of proposals and applications must pass on both criteria to be considered fundable
- The Steering Group consists of 7 academic members (nominated by BBSRC and EPSRC) and 7 industrial representatives (chosen by the industrial Club members).
- For assessments conducted by the Steering Group, each full proposal has two Introducing Members (IMs). One IM is from academia and the other is from industry.
- The procedure for dealing with conflicts of interest (e.g. where a Steering Group member has pre-existing links to an applicant) is the same as for other BBSRC Research Committees. Conflicted individuals leave the room while the proposal is being discussed.

ELIGIBILITY

UK Higher Education Institutions, Independent Research Organisations and BBSRC-sponsored institutes are eligible to apply.

CONTACTS

For further information contact:

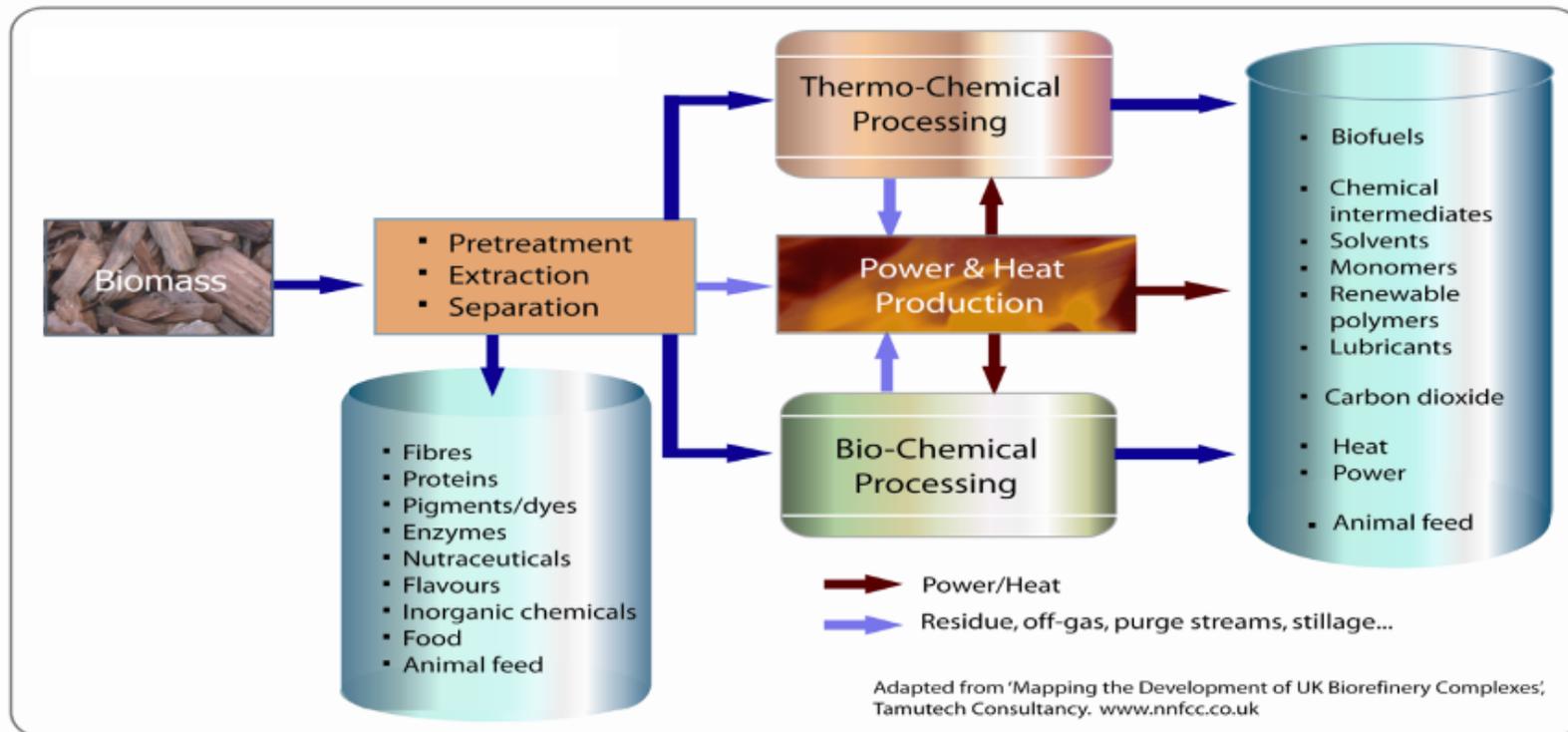
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IBTI Club Academic Coordinator

Professor Christopher Knowles
chrisjknowles@btinternet.com

GENERIC DIAGRAM OF A BIOREFINERY PROCESS



GRANTS FUNDED THROUGH FIRST CALL APRIL 2009

Optimization of Wheat and Oilseed Rape Straw Co-products for Bio-alcohol Production	
Ian Bancroft	John Innes Centre
Keith Waldron	Institute of Food Research
<p>Various forms of biomass represent potential feedstocks for degradation and fermentation to produce alcohols as liquid biofuels, with residual protein-rich materials being suitable for further exploitation, such as processing for animal feed. This provides the potential to substantially substitute for fossil fuels, with the associated sustainability and environmental benefits. However, some of the sources evaluated in recent years could compete directly with UK food crops for land use. With the growing recognition of the vulnerabilities of world (and UK) food security, and associated food price volatility, it is becoming increasingly clear that the displacement of food crops by crops grown solely for biofuel is inappropriate. There are, however, several sources of "waste" biomass associated with the UK production and processing of food crops. These provide potential feedstocks for "biorefining" to recover biofuels and animal feed from residues after grain/seed recovery. This approach does not compete with food crops; indeed the increased value of co-products such as straw should enhance the financial viability of food crop production in the UK.</p> <p>Major UK food crops such as wheat and oilseed rape produce more straw co-product than harvested grain or seeds. This straw constitutes a plentiful potential feedstock. However, these crops have been bred for the quality and yield of grain or seeds, not for the composition of the straw they produce. Past studies have revealed variation for the major chemical constituents of importance for bioalcohol production.</p> <p>We are already involved in an ongoing research programme, funded by Defra, which is developing the methodology for the efficient exploitation of biomass residues from the food chain. The proposed research dovetails with this project, providing the means to optimise the principal feedstocks: wheat and oilseed rape straw. Combined, these two projects will establish the supply chain (from breeders and farmers to bio-alcohol producers and the motor industry) needed to deliver the financial and societal benefits of the science.</p> <p>We aim to thoroughly analyse the composition of straw from current wheat and oilseed rape varieties, and of genetic material in use by breeders, for compositional characteristics of importance for biofuel production. We will use recently developed technologies to explore variation of the sequences and expression of tens of thousands of genes in each of wheat and oilseed rape, and relate these genetic characteristics to the compositional characteristics of the lines in order to develop markers for use in subsequent breeding programmes. Using the information we have gained, we will hypothesise the processability characteristics of differing potential feedstocks and test these using a pilot plant system.</p>	

Aromatic Feedstock Chemicals from Degradation of Lignin	
Timothy Bugg	University of Warwick
<p>One of the biggest problems facing society today is our dependence on dwindling fossil fuels, and the contribution to global warming of power stations, car transport and domestic heating that make use of fossil fuels. Not only is oil used to prepare fuel, but also an essential by-product of oil refining is the production of raw materials for chemical and pharmaceutical synthesis. In 50-100 years time, all of these chemicals will need to be produced from renewable, nonpetroleum sources, but at present we have very limited methods to do this, so a lot of new technology needs to be developed in a relatively short space of time.</p> <p>The carbon content of plant lignocellulose, found in plant cell walls, represents an abundant source of renewable carbon. One component of lignocellulose is an aromatic polymer called lignin that binds the cellulose cell walls together. Lignin is very hard to break down, so at present lignocellulose is broken down via a "pre-treatment" step, usually involving heating with acid and steam to 200 oC, which consumes a lot of energy. Therefore, if we could use Nature to break down the lignin, we would improve the efficiency of lignocellulose breakdown, and liberate useful aromatic by-products.</p> <p>We have recently developed a new method for identifying strains of bacteria that are able to break down lignin, and we have already found several strains of bacteria that are able to do this. We will isolate the lignin-degrading enzymes from these strains, and use molecular genetics to produce large quantities of these enzymes for further studies. We will then use these strains to try to produce useful aromatic chemicals from breakdown of lignocellulose. One example is vanillin, which is used for food flavouring in products such as vanilla ice cream; other examples are phenols that are used in the manufacture of plastics.</p>	

In Silico Study of Lignocellulosic Biofuel Processes

Michael Bushell

University of Surrey

In theory, a genome sequence provides all of the information necessary to define the structure of the biological system of interest. For example, knowing all of the enzymes in a cell and the substrates that each one accepts and all of the products that each one can make, it is possible to formulate a bioreaction master global network that represents the complete repertoire of possible biochemical reaction systems within that cell. In this study, we plan to use a "genomescale" metabolic network (gsmn), reconstructed from the sequence data for a number of species with applications in biofuel production. Gsmns have already been published for a number of medically- and industrially-important species, including *Streptomyces coelicolor* and *Mycobacterium tuberculosis* (these 2 by us) facilitating novel approaches to process design and identification of antibiotic targets, respectively.

We plan to use genome scale modelling to demonstrate the utility of in silico experimentation to Biorefining. The approach will link genomes, capable of carrying out lignocellulose degradation to genomes able to produce biofuels, with a view to predicting processes that will form the basis for an in vivo study. As far as we are aware, this will be the first project to link genome scale models in this way, and will therefore represent a scientific advance in addition to providing pragmatic information. This 2-stage (biomass degradation followed by a separate bioethanol production stage) is potentially more efficient than a single microbial processing step.

Biomass Degradation

The genomes of two "model organisms" (the fungus *Trichoderma reesei* and the bacterium *Clostridium thermocellum*) have recently been sequenced and these species will, therefore, be included in the study. However, considering the current dependence on acid and heat pre-treatment in lignocellulose degradation, enzymes that are stable and active at low pH values and at high temperatures are of particular value. Thus, enzymes derived from thermophilic and acidophilic organisms known to degrade lignocellulose hold significant promise for industrial processes, and, for this reason *Caldicellulosiruptor saccharolyticus* and *Acidothermus cellulolyticus* (both of which have been sequenced) will be included in the biomass degradation stage.

Biofuel production

A significant yield limiting factor is the toxicity of ethanol to the fermenting host. Most fermenting organisms such as *S. cerevisiae* cannot tolerate high ethanol concentrations resulting in a product that must then be concentrated through an expensive and energy-intensive distillation step. *Pichia stipitis* represents one yeast species of relevance to biofuel research based on its natural ability to ferment xylose. Its recently sequenced genome revealed insights into the metabolic pathways responsible for this process and this species will be included in our second stage modelling. *Zymomonas mobilis*, which has been described as having considerable potential for biofuel production has also been sequenced recently and will be included. Finally, the use of *E. coli*, which has been engineered to produce isobutanol and other alcohols, using non-fermentative pathways, will be included. The feed-stocks to be examined for biomass degradation will include lignocellulose (with and without chemical pre-treatment) and co-substrates, which may enhance bioenergetic efficiency of metabolism. Each of the four species will have gsmns constructed. In each case, a "draft" gsmn will be prepared (using the sequence annotations) which will be refined by the addition of further reactions in order to "close" the model. Each gsmn includes numerous (often hundreds of) "input gates", ie potential substrates, predicted by the gene sequence but never tried in the laboratory. Using in silico models, we will be able to examine the effect of combinations of substrates that would require many years of experimentation in vivo.

Engineering Oilseeds to Synthesise Designer Wax Esters

Johnathan Napier

Rothamsted Research

Waxes are a type of lipid which have useful properties, specially as lubricants. The modern industrial world is dependent (literally) on the smooth running of millions of machines and processes, all of which require lubricants to reduce friction and wear & tear. Currently, most lubricants are made from crude oil by chemical transformations, a process which consumes this diminishing natural resource both as a feedstock and as a source of energy to drive the reaction. In other words, petrochemically-derived lubricants are unsustainable. Whilst plant seeds produce oils, these are not very effective as lubricants as they are prone to oxidising which makes them sticky. However, one particular plant, jojoba, makes a different class of oil to that found in all other plant seeds. Jojoba seeds accumulate wax esters, rather than triacylglycerols, and waxes have far superior lubricating properties compared with the normal seed oils. Unfortunately, jojoba plants only grow in American deserts, which preclude their use in European agriculture. To circumvent this problem, we propose to transfer the genes for wax biosynthesis from jojoba (and other organisms which make wax esters) to suitable plant species for evaluation and testing. It is proposed to use *Arabidopsis* as a model system to identify the best combination of genes to make waxes with the most useful properties, and having determined these, introduce them into a dedicated industrial oilseed crop, *Brassica carinata* (Ethiopian mustard). Importantly, by using a crop species that is not used to produce food, this will ensure that our waxes (to serve as biolubricants) will not enter the human food chain. Overall, this project aims to demonstrate the feasibility of substituting plant-derived wax esters for petrochemically-derived lubricants, providing a new green, sustainable source of these important compounds.

IBTI CLUB MANAGEMENT

The Biosciences Knowledge Transfer Network (KTN) is coordinating the Integrated Biorefining Technologies Initiative (IBTI) to establish a strategic initiative in biorefining technologies. The aim of IBTI is to establish programmes of strategic problem-solving research focussed on diverse raw material feedstocks and the essential conversion technologies necessary to realise their economic potential.

As part of the delivery of BBSRC's Technology Strategy Underpinning Industrial Needs, BBSRC invited the KTN to identify industrially relevant research challenges and interested companies that could form the basis of a Research & Technology Club. As a result of this, BBSRC and EPSRC have agreed to make available funding for underpinning basic research on biorefining technologies within their remits through the establishment of the Integrated Biorefining Research & Technology Club (IBTI Club).

Management of the peer-review of applications submitted to the IBTI Club is provided by BBSRC. The assessment of applications is performed by the IBTI Club Steering Group, who rank applications based on science quality and industrial relevance, and make funding recommendations to the BBSRC and EPSRC.

The IBTI Club will operate for 5 years, supporting research through at least two calls for proposals. The Club will be managed by BBSRC in coordination with EPSRC, and research projects will be awarded as BBSRC grants using peer review processes as for fully public funded research. The management of the peer review of applications submitted to the Club will be performed by BBSRC.

BBSRC has appointed an Academic Coordinator and an Industrial Coordinator to assist with the management of the Club. The Academic Coordinator works with the academic community in the development of project proposals and monitor progress of funded projects. The Industrial Coordinator works with company members to canvass views, promote Club activities, and keep industry members informed of developments. The Coordinators will work together to facilitate networking between the funded research groups and industry and ensure the success of the club.

IBTI CLUB MEMBERSHIP

The Club, which currently has 10 Industrial Members, will support research projects from a fund, joint with the BBSRC and EPSRC, of just under £6M. Industrial Members make annual contributions to the funding pot based on corporate size and between them will contribute £660K. BBSRC will invest £4M and EPSRC will invest £1.2M.

Organisations that have agreed to join the IBTI Club as of 23 September 2009 are:

Biocaldol Ltd
BP Biofuels UK Ltd
British Sugar Plc
Croda Enterprises Ltd
Green Biologics Ltd
HGCA
InCrops Project
KWS UK Ltd
Syngenta Ltd
TMO Renewables Ltd

Researchers receiving IBTI Club funding will become Academic Club members.

STEERING GROUP

A Steering Group made up of 6 Research Council nominees, 6 members nominated by Industrial Club Members and Chaired by Peter Fryer of BBSRC Council has been established for the IBTI Club. The role of the IBTI Club Steering Group is primarily to establish the nature of research to be funded in the two IBTI Club calls for proposals and to peer-review applications submitted.

The IBTI Club Steering Group Membership is as follows:

Industrial Members

Namdar Baghaei-Yazdi, Biocaldol
Surinder Chahal, Croda
Raymond Elliott, Syngenta
Fergal O'Brien, Green Biologics
Jason Robinson, TMO Renewables Ltd
Richard Safford, HGCA
Christopher Tapsell, KWS

Academic Members

Michael Bushell, University of Surrey
James Clark, University of York
Robert Edwards, Durham University
Alexei Lapkin, University of Warwick
Simon McQueen-Mason, University of York
Johnathan Napier, Rothamsted Research
Gill Stephens, University of Manchester

IBTI CLUB MEMBERS & COMPANY INFORMATION

Biotechnology and Biological Sciences Research Council (BBSRC)
Biosciences Knowledge Transfer Network
Biocaldol Ltd
BP Biofuels UK Ltd
British Sugar Plc
Croda Enterprises Ltd
Engineering and Physical Sciences Research Council (EPSRC)
Green Biologics Ltd
HGCA
InCrops Project
KWS UK Ltd
Syngenta Ltd
TMO Renewables Ltd

Biotechnology and Biological Sciences Research Council (BBSRC)

BBSRC is the UK's principal funder of basic and strategic biological research. To deliver its mission, BBSRC supports research and research training in universities and research centres throughout the UK, including BBSRC -sponsored institutes; and promotes knowledge transfer from research to applications in business, industry and policy, and public engagement in the biosciences.

BBSRC is a non-departmental public body, supported through the Science Budget by the Department of Business, Innovation and Skills via the Office of Science and Innovation. BBSRC works with partner Research Councils through Research Councils UK.

Website: www.bbsrc.ac.uk

Biosciences Knowledge Transfer Network

The Biosciences KTN is a Government-funded Knowledge Transfer Network designed to accelerate the rate of technology transfer into UK business and improve innovation performance. The Biosciences KTN has been established to serve the Agriculture, Food and Industrial Bioscience Sectors and is the most important conduit for bio-based technology business to engage with government, other business, research and trade organisations.

The move towards a bio-based economy requires the use of renewable feedstocks for the production of chemicals, materials, energy and fuels. The supply chains required for production, extraction, purification and transformation of these biologically-source renewable materials are served by the Biosciences KTN. The diverse components of research, development and demonstration required for effective exploitation of natural materials in this new economy are strategically unified by several complementary KTN-led initiatives aimed at securing a long-term competitive advantage for UK industry.

Website: www.biosciencektn.com

Biocaldol Ltd

Biocaldol Ltd. specialises in developing turnkey solutions designed to transform the agro-industry. These solutions comprise proprietary, environmentally-friendly micro-organisms, custom-made process design and engineering for the production of second-generation biofuels, animal feed and other biomass-derived products.

The current focus of Biocaldol business is system integration. Biocaldol works closely with customers and agro-industrial partners to retrofit conventional ethanol plants, develop process components, provide engineering expertise and gain marketing access within the key market sectors.

Website: www.biocaldol.com

BP Biofuels UK Ltd

BP is one of the world's largest energy companies, providing its customers with fuel for transportation, energy for heat and light, retail services and petrochemicals products for everyday items. It is the largest oil and gas producer in the U.S. and one of the largest refiners. BP also has a global network of around 25,000 service stations.

BP is a leading player in the global biofuels market. In the US, BP blended and distributed 763 million US gallons of ethanol and about 1 million US gallons of biodiesel during 2007. In Europe, BP sold 344 million litres of ethanol and 847 million litres of biodiesel during 2007. BP's sales of biofuels in 2007 accounted for about 10% of the global biofuels market.

Website: www.bp.com/biofuels

British Sugar Plc

British Sugar is the leading supplier of sugar to the UK market, producing more than 1 million tonnes of white sugar each year from beet. Our products are represented in the leading brands of all of the major global food and drink manufacturers. Processing more than 7 million tonnes of sugar beet also results in a range of additional products for other markets, like agriculture, salad crops, landscaping, soil improvement and biofuels.

As one of the UK's leading agriprocessors with an interest in innovative new technology, British Sugar began production of bioethanol in September 2007 making it the first company to manufacture bioethanol in the UK. British Sugar is able to supply bioethanol with full traceability including a full life cycle analysis. This is necessary to demonstrate that the whole process of production, including crop growing, fermentation and distribution, is carried out in such a way that genuine environmental benefits are delivered.

Website: www.britishsugar.co.uk

Croda Enterprises Ltd

Croda is a world leader in natural based speciality chemicals which are sold to virtually every type of industry. The company has approximately 4000 employees, working at 43 sites in 36 countries. Our activities can be broadly classified into two sectors: Consumer Care which consists of global businesses in personal care, health care, home care and crop care – all markets with an increasing need for innovation and sustainable ingredients; and Industrial Specialities which comprises base oleochemicals, additives for polymers, polymers and coatings, lubricants and lubricant additives, and processed vegetable oils.

Croda employs a variety of 'traditional' chemical processes to convert natural based raw materials (mainly vegetable oils and fats such as rapeseed, coconut and palm oils) into fatty acids and glycerol, and then further refine and process them into a range of functional specialities. In addition, however, Croda has developed its own technologies. With technical centres strategically located worldwide, our technologists work closely together, sharing ideas and information, to ensure that Croda is always at the leading edge of new technology in all its chosen markets.

Website: www.croda.com

Engineering and Physical Sciences Research Council (EPSRC)

EPSRC is the main UK government agency for funding research and postgraduate training in engineering and the physical sciences, investing more than £800 million a year in a broad range of subjects - from mathematics to materials science, and from information technology to structural engineering.

EPSRC is a non-departmental public body, supported through the Science Budget by the Department of Business, Innovation and Skills via the Office of Science and Innovation. EPSRC works with partner Research Councils through Research Councils UK.

Website: www.epsrc.ac.uk

Green Biologics Ltd

Green Biologics Limited (GBL) is an industrial bio-technology SME, based near Oxford, pioneering advanced microbial technologies for the conversion of sugars to renewable chemicals and fuels. More specifically, GBL is a world leader in Clostridial ABE (Acetone-Butanol-Ethanol) fermentation and supplies advanced bio- butanol process solutions to large feedstock owners and chemical producers. The company is currently working with a number of feedstock partners across three continents to pilot and demonstrate its proprietary process.

Website: www.greenbiologics.com

HGCA

Mission: To improve continuously the production, wholesomeness and marketing of UK cereals and oilseeds so as to increase their competitiveness in UK and overseas markets in a sustainable manner.

Our Role: HGCA provides high quality cost-effective services, designed to meet the needs of levy payers, whilst taking account of both consumer and environmental requirements. Working closely with levy payers to ensure that there is an effective exchange of knowledge and understanding along the grain chain, HGCA generates and disseminates independent information to help support a competitive and sustainable arable industry.

Website: www.hgca.com

InCrops Project

The InCrops enterprise hub has been developed to: stimulate through new business assistance and activity the commercialisation of new biorenewable and low carbon products from alternative and non food crop feedstocks; in order to stimulate new business activity lever out the East of England's world class research capability in plant and crop science; to support the business and commercial sector and stimulate sustainable economic growth through supply chain; development, market integration and product innovation; accelerate the rate of successful technology transfer into the business and commercial environment; through new exploitation platforms widen the scope for technology transfer; proactively support commercialisation through business spin outs and business incubation support in the East of England. The InCrops project is funded by the East of England Development Agency (EEDA) and part-funded by the European Union ERDF.

Website: www.incropsproject.co.uk

KWS UK Ltd

KWS UK is a leading provider of agricultural seeds (cereals, oil-seeds, sugar beet and maize) dedicated to providing UK growers with innovative new varieties to meet increasingly demanding end-market needs. It is part of the KWS Group which operates in 65 countries, has a turnover of 537million euros and a staff of 2,700.

KWS is a leading seed company in the bio-energy area with dedicated breeding programmes for Bio-energy Maize and Sorghum and numerous R&D links with academics across Europe.

Website: www.kws-uk.com

Syngenta Ltd

Syngenta is a world-leading agribusiness. We are committed to sustainable agriculture – farming with future generations in mind. We contribute to that in many ways, for example by raising productivity through innovative research and new technology. Our company provides two main types of products: seeds and crop protection. Syngenta helps growers around the world increase their productivity and address the world's growing demand for food, feed and fuel.

Syngenta was created in 2000. Syngenta is a leader in crop protection, and ranks third in the high-value commercial seeds market. Sales in 2007 were approximately \$9.2 billion. The company employs over 21,000 people in more than 90 countries. Our experience with plants goes back many decades. All around the world, our scientists work with a vast range of crops in local conditions, and share their insights globally. Bringing plant potential to life is our company purpose.

Website: www.syngenta.com

TMO Renewables Ltd

TMO Renewables Ltd was founded in 2002, TMO Renewables Ltd has developed a technology which is described as “the sponsor of a paradigm shift in the production of ethanol from biomass”. At the core of TMO's offering is an ethanologen, developed in their laboratories, which is performing today at the levels set by the US Department of Energy for targets to be reached in 2011. This thermophilic organism operates at high temperatures and digests a wide range of feedstocks very rapidly. TMO has developed a process which exploits these properties to make ethanol from cellulosic biomass in a manner which eliminates the economic barriers that have restricted the development of cellulosic ethanol production.

TMO has built and is currently operating their Process Demonstration Unit (PDU) which is designed to handle a wide variety of feedstocks including wheat straw, corn stover, corn fibre, wood chips, switchgrass, distillers grains etc. It was designed for the upmost flexibility and includes TMO's bespoke design for pretreatment, enzyme hydrolysis and fermentation working in batch or fully continuous mode.

TMO intends to offer this second generation technology in the first instance to the existing corn ethanol sector. By “bolting on” a TMO designed facility at an existing corn ethanol plant, the distillers dried grains and soluble (“DDGs”) that arise as a co-product can be further processed into additional ethanol. This will deliver significant energy savings to the plant owner by eliminating much of the DDGs drying requirement: the TMO process requires a wet feedstock. After the cost of corn, drying costs represent the second largest element of the cost of production in corn ethanol. The impact of a twelve to fifteen percent increase in ethanol production from the cellulosic co-product when combined with the existing starch derived ethanol results in a significant margin increase for the producer.

Website: www.tmo-group.com

DELEGATE LIST

Prof Galip Akay

Chemical Engineering and Advanced Materials, Newcastle University

Current Role & Research Activities: I have a research group of ca. 20 PhDs+Post Docs+Visiting Academics dedicated to the development of Intensified Integrated Biomass Based Energy and Chemicals Technology (i.e., Intensified Integrated Bio-refinery Technology) with current funding from EPSRC, Carbon Connections, Technology Strategy Board (Carbon Abatement Technologies), Several Industries, EU (FW7-Integrated Project). I am also the R&D director of ITI Energy which manufactures gasifiers for syngas production and power generation from biomass (waste). My research invariably relates to process intensification and includes agriculture (for biomass generation), biotechnology for biomass-to-biofuel conversion (fermentation), gasification/syngas generation /syngas cleaning, syngas-to-liquid conversion (including FT synthesis and fermentation), intensified reactors (bio and chemical), catalysts and novel intensified production routes. I was the coordinator of a 5-university EPSRC project 'Intensified Integrated Biorefinery Technology) which started in 2006 and was completed recently with 5 patent applications made by Newcastle, Bristol and Oxford Universities. I am a founding director of UK Children's Neurological Research Campaign

Dr Mike Allen

Plymouth Marine Lab

Current Role & Research Activities: Microbiology/Virology/Molecular Biology/Marine Biology Algal Biofuels

Prof Ahmed Al-Shamma'a

General Engineering, Liverpool John Moores University

Current Role & Research Activities: Head of Research, Advance biorefinery systems using microwave technologies

Dr John Andresen

Chemical and Environmental Engineering, Nottingham University

Current Role & Research Activities: Associate Professor. Main interest in bio-refining of alternative bio-mass material for sustainable liquid fuels. Have established a 15kg/h pyro-catalytic pilot-scale plant at University of Nottingham with East-Midlands company.

Dr Namdar Baghaei-Yazdi

IBTI Club Steering Group Member
Chief Technical Officer, Biocaldol

Dr Simon Baker

Life Sciences, Oxford Brookes University

Current Role & Research Activities: Group Leader: Bioprocessing. The bioprocess research group at Brookes focuses on microbiological, molecular biological and engineering aspects of the overproduction of high value microbial products. Recent research work has focused on the accelerated evolution of stable, chirally selective nitrilases (funded by the BBSRC) and the overproduction of biosurfactants by foam fractionation (EPSRC), improved expression analysis (industrial funding) and cell screening systems. We have coupled our work on a model biosurfactant (surfactin) to recent advances in module shuffling at the genetic level and this opens the possibility of using surfactin modules as an effective scaffold for biomimetics. This approach is a novel yet practical way of enhancing the cost effective separation of high value products from low concentration solutions.

Dr Guy Barker

WarwickHRI, Warwick University

Current Role & Research Activities: The metabolite profile within an organism is affected by both its environment and its genetics. In developing the bio refinery concept an understanding of the effects these factors can have on the economics of a given process is vital. We have demonstrated this through on ongoing interdisciplinary EPSRC project looking at the "Adaptive processing of natural feedstock's". This has involved isolation and analysis of metabolites and how different factors effect the extractability of high value compounds. In collaboration we are also looking at the concept of biorefineries and the problems involved with the extraction of multiple components from a given biomass and how to cope with the natural variability which will occur within the feedstock and how we can influence the plants production of specific compounds.

Dr Will Barton

Innovation Programmes, Technology Strategy Board

Current Role & Research Activities: Head of Technology Manage the Department of

Technologists focussed on the organisation's Key Technology Areas

Dr Muhammad Noman Biag

Chemical Engineering, Birmingham University

Current Role & Research Activities: Working as Research Fellow in the department of Chemical Engineering at University of Birmingham. Research activities involved in extraction and fractionation of natural products/biomass using supercritical CO₂ and sub-critical water hydrolysis. Research interests are based around studying process systems to develop simplified models using RSM (response surface methodology) particularly in the area of biotechnology & waste/biomass processing.

Ms Clare Bumphrey

IBTI Club Liaison

Physical Sciences Portfolio Manager, EPSRC

Dr Kerry Burton

WarwickHRI, Warwick University

Current Role & Research Activities: I am a PI at Warwick and currently have two PhD students working on microbial biorefining and I am a Co-I on two projects: Wealth Out of Waste (EPSRC funded) and Aromatic Feedstocks Chemicals from the degradation of Lignin (BBSRC [IBTI]). My research activities are concerned with extracted feedstock chemicals from the lignocellulose of crop wastes (e.g. wheat straw as exemplar). This waste stream is plentiful, renewable and already harvested. The challenge is to break down lignocellulose with low inputs to produce chemical outputs, concentrated and with some degree of separation. My research is biological and is concerned with using fungi and bacteria to pre-treat and break down lignocellulose followed by chemical extraction of the released products. The projects are multidisciplinary and involve biologists, chemists and engineers. Initial results from non-optimised systems have shown that significant levels of sugars can be extracted in the aqueous phase and aromatics extracted in the aqueous and organic solvent phases. In addition, a fatty acid layer can be separated from the organic solvent extract. I have also an interest in 'Science and Society' and I have recently submitted a paper with reference to biorefining and bioenergy describing some of the issues of how society makes the difficult decisions between adopting new environmental technologies (e.g. biorefining and wind turbines) and damage to the environment, landscape and wild-life by these technologies.

Prof Michael Bushell

IBTI Club Steering Group Member

Division of Microbial Sciences, University of Surrey

Current Role & Research Activities: My current interests involve genome scale metabolic network modeling and advanced bioreactor technology applied to the physiology of a range of microorganisms.

Specific topics include antibiotic biosynthesis, bioreactor performance and micro-morphology of *Streptomyces*, recombinant protein production in *Pichia pastoris* and the role of *Pseudomonas* infections in cystic fibrosis.

Dr Surinder Chahal

IBTI Club Steering Group Member

Technical Director, Enterprise Technology, Croda

Ms Kristine Cherry

IBTI Club Programme Manager

Senior Business Interface Manager, BBSRC

Dr Neil Crawford

Bioenergy Programme Manager, BBSRC

Dr Daniel Eastwood

WarwickHRI, Warwick University

Current Role & Research Activities: Senior Research Fellow investigating the use of basidiomycete fungi in the solid state fermentation of plant wastes to yield novel chemical feedstocks and sugars for industrial exploitation. Special interest in lignocellulose decay by brown rot fungi, I co-ordinate the genome sequencing programme of the dry rot fungus, *Serpula lacrymans*, and serve on the Fungal Genomes Programme Committee of the USA Department of Energy Joint Genome Initiative to direct future genome projects in relation to bioenergy research. Teaching duties include running a module on Bioenergy and Biorefineries delivered to both Undergraduates and Masters students.

Prof Rob Edwards

IBTI Club Steering Group Member

Bioactive Chemistry, Durham University

Current Role & Research Activities: Research interests plant secondary metabolism/ biotransformation/ metabolic engineering of bioactive plant products/ herbicide selectivity and crop protection

Dr Kirstin Eley

External Programme Manager, TMO Renewables

Dr Tony Fentem

IBERS, Aberystwth University

Current Role & Research Activities: Research funding and business development for the Crop Genetics, Genomics and Breeding Division. Optimisation of oat, grass and legume feedstocks through breeding to deliver economic levels of high value components for industrial use. Development of crop processing technologies.

Prof Rob Field

Biological Chemistry/Metabolism

Programme, JIC Norwich

Current Role & Research Activities: The Field group is based in carbohydrate chemistry and chemical (glyco)biology, with research programmes on the (bio)chemistry of starch and the plant cell wall, and natural products glycosylation. Collaborative work with a UK-wide team of chemists and biologists has seen the establishment of carbohydrate microarray platforms for high through-put carbohydrate-protein interaction and carbohydrate-active enzyme analysis. Recently established collaborative work at JIC is investigating the potential of in planta and in vitro expression systems for the generation of added-value glycosylated natural products and glycopolymers. <http://www.jic.ac.uk/profile/Rob-Field.asp>

Dr Paul Fraser

Biochemistry, RHUL

Current Role & Research Activities: Group leader: Biosynthesis, regulation and engineering of isoprenoid formation in plants and microbes.

Prof Peter Fryer

IBTI Club Steering Group Chair

University of Birmingham, BBSRC Council

Prof Patricia Harvey

School of Science, University of Greenwich

Current Role & Research Activities: Head of the Bio-Energy Research Group. Biofuels (Biosynthesis and deposition of neutral long-chain lipid production in microalgae, Effect of humic materials on microalgae performance, Jatropha oil as a fuel and source of high value natural products, Biofuel supply chains and bio-refining, Renewable liquid fuels and biogas for mini-scale CHP, Biodiesel from plant oils; production, purification and novel catalytic processes for trans-esterification of triglycerides, AD of food and agricultural wastes, Analytical methods for solid and liquid biofuels); Phytotechnologies (Phytotechnologies to promote sustainable land use management and

improve food chain safety, Plant Biotechnology for the removal of organic pollutants and toxic metals from wastewaters and contaminated sites, Bio-phytoremediation of contaminated land); Oxidative Metabolism (Role and mechanisms of lignin peroxidase catalysis, Role and regulation of the alternative oxidase by organic acids in sweet potato cell culture, Regulation of the redox cycle of peroxidases with hydroxamic acids); Respiratory pathways and oxygen toxicity in *Phanerochaete chrysosporium*.

Dr David Hodgson

Chemistry, Durham University

Current Role & Research Activities: Lecturer in the Department of Chemistry
Keywords: Physical organic chemistry, synthetic chemistry, chitin biosynthesis, chitin extraction, chitin biosynthesis inhibition, glycosyl transferase inhibition, nucleic acids, ribozymes, plant metabolism, enzymology. Having initiated a project on the extraction of chitin and chitosan from fungi we found that many of the analytical techniques in the literature for determining the properties of these materials were unsatisfactory. One of the critical parameters for the commercial usage of chitin (eg in biomed., food etc) is the degree of acetylation, however, many methods for the determination of this parameter rely on partial solubility of this, essentially insoluble, material. With this in mind, we have developed novel, inexpensive systems for the 15-N labelling of chitin in fungi, then, after extraction the degree of acetylation could be readily determined via solid state NMR analyses (ssNMR). ssNMR acquisition times were cut from ~1 day to ~0.5 h whilst increasing the signal to noise ratio of the spectra that were obtained with consequent improvements in the accuracy of the degree of acetylation determinations. This work has been published in (*Biomacromolecules* 2009, 10, 793-797). Subsequently, using cross polarisation ssNMR techniques we have been able to insert whole (live, sterilised, dried) fungi into the NMR machine and obtain reasonable 15-N ssNMR spectra that contain signals for the macromolecular chitinous materials, but very little else. Thus, DA could be determined directly on the fungi without time-consuming extraction procedures. In addition, 13-C ssNMR spectra could also be obtained under these conditions (manuscript in preparation). Whilst these results are very promising, we believe that in future we could develop our labelling and ssNMR techniques to allow the determination of the AMOUNT of chitinous material in a given volume of mycelia in addition the the degree of acetylation. Furthermore, with detailed analysis of the 13-C ssNMR outputs we also hope to be able to gain insight into the amount of

contaminating glucans that are present. With this two approaches in hand we would hope to be able to screen different fungi and growth conditions of known chitin producing fungi for their abilities to produce large amounts of chitinous materials of an appropriate acetylation state with minimal contamination from glucans. On these bases, we believe we can develop potent tools for the optimisation of chitin/glucosamine feedstocks from fungal culture. In a broader context, one of us (Apperley) runs the UK EPSRC ssNMR service. In the past he has worked on ssNMR determinations on cellulosic materials. Lignins, however, do not respond well to the ssNMR analyses, but through labelling (insofar as this is possible with plants), and the development of appropriate new NMR techniques, we may also be able to gain insight into these recalcitrant materials.

Dr Tom Jenkins

IBTI Club Industrial Coordinator
Bioscience for Business

Prof Christopher J. Knowles

IBTI Club Academic Coordinator
Oxford Innovation

Current Role & Research Activities: Formerly Professor of Environmental Science at the University of Oxford, with interest in microbial bioremediation and biocatalysis.

Prof Alexei Lapkin

IBTI Club Steering Group Member
Engineering, Warwick University

Current Role & Research Activities: Professor of Engineering; Over the last two years I was coordinating a Sandpit project on adaptive technologies for processing biomass. We learned a great deal about various stages of a biorefinery process, not least some new challenges in biology, chemistry, engineering, supply chain, complexity, etc.

Dr David Leak

Life Sciences, Imperial College

Current Role & Research Activities: Reader in Applied Microbiology. Research activities in metabolic engineering for biofuel/chemical production, with particular expertise in working with *Geobacillus* spp. Associated projects in biomass pre-processing including novel methods such as using ionic liquids. We are also working on a BRIC project addressing problems in protein secretion for *Pichia pastoris*, and have broad interests and expertise in applied biocatalysis

Dr Aiduan Li

Environmental Engineering, University
College London

Current Role & Research Activities: Research fellow. Research interests include advanced biomass conversion processes for liquid biofuel, utilizing lignocellulosic materials including waste residues and byproducts recovery.

Prof Jenny Littlechild

Biosciences, Exeter Biocatalysis Centre,
Exeter University

Current Role & Research Activities: Director of Exeter Biocatalysis Centre Industrial Applications of Enzymes Specialising in Thermophilic Enzymes Structure, Substrate Specificity, Biotransformations Design of Mutant enzymes suitable for Industrial Applications

Dr Gianluca Memoli

Acoustics and Ionising Radiation, National
Physical Laboratory

Current Role & Research Activities: Higher Research Scientist at the Acoustics and Ionising Radiation Division of the National Physical Laboratory. The main research is about the precise measurement of acoustical cavitation; Preliminary studies have been completed on the possibilities of improving bio-refining processes by added controlled ultrasound (preliminary study), determining ultrasonic measurement techniques for grade of blend and other physical parameters.

Prof Johnathan Napier

IBTI Club Steering Group Member

Biological Chemistry, Rothamsted Research
Current Role & Research Activities: Metabolic engineering of plants for high value products.

Mr Rafael Orozco

Biosciences/Chemical Engineering,
Birmingham University

Current Role & Research Activities: Working on high value chemicals and hydrogen production from biomass&biowastes by integrating thermochemical and biological processes

Dr Sreenivas Rao Ravella

Bioenergy, North Wyke Research

Current Role & Research Activities: Currently fermentation scientist in the bioenergy team at North Wyke Research. North Wyke Research is an institute of Biotechnology and Biological Sciences Research Council (BBSRC), UK. Research interests mainly concern biofuels production, biogas, lignocellulosic hydrolysis, xylose and ethanol fermentations, xylitol production, diversity of microorganisms

especially yeasts from different habitats and extremophiles, fermentation optimizations using Taguchi Method, process control, exploiting novel yeast species to value added biotech products.

Mr Jason Robinson

IBTI Club Steering Group Member
Associate Director of Engineering, TMO
Renewables Ltd.

Dr Andrew Ross

Energy and Resources Research Insitutue,
Leeds University
Current Role & Research Activities: RCUK fellow
in Low Carbon Energy Technologies
Hydrothermal processing of algae Pyrolysis and
liquefaction Characterisation and evaluation of
biofuels Manage the Supergen marine biomass
activity

Dr Richard Safford

IBTI Club Steering Group Member
Industrial Uses Project Manager, HGCA

Dr Gill Stephens

IBTI Club Steering Group Member
Manchester Interdisciplinary Biocentre,
University of Manchester
Current Role & Research Activities: Biocatalytic
Reductions, Improving the stability of whole cell
biocatalysts, Biocatalysis in ionic liquids,
Integrating biocatalysis with chemocatalysis

Dr Edward Taylor

Chemistry, York University
Current Role & Research Activities: I currently
hold a Royal Society University Research
Fellowship entitled "The Structural and functional
analysis of a prophage from Streptococcus
pyogenes". Research Activities: I have a general
interest in the activity and structure and function
of carbohydrate active enzymes. More
specifically in enzymes which make and break
carbon-carbon bonds. Structural analysis of
carbohydrate active enzymes involved in the
dissimilation of plant material. Another
interesting area of our work involves the
structural analysis of carbohydrate active
enzymes involved in the dissimilation of plant
material. Plant polysaccharides are complex in
nature and are made of many different sugars
with many different linkages that form an
interlocking mesh. These are insoluble and so
immediately inaccessible to heterotrophic
organisms. The digestion of the plant cell wall
requires the concerted action of a diverse
repertoire of enzyme activities. We have used

structural information to investigate the
mechanisms by which some of these enzymes
operate^{3,5-9}. Using bacterial lysins. Lysins are
enzymes which act on different bonds found in
peptidoglycan, an important bacterial cell wall
polymer. Their role in nature has shown to be
either as cell wall modulating enzymes, which
enables processes such as cell division, or as a
component of the phage life cycle which causes
the bacterial cell to burst open to allow the
dissemination of the new phage particles. There
is currently an interest in harnessing the lytic of
properties bacterial lysins as antimicrobial
agents. We are investigating the mechanisms by
which some of these enzymes operate⁴.
Structure and functional analysis of medically
important bacteriophage. My other interests lie in
the interplay between certain pathogenic
bacteria and their compatible bacteriophage. In
some cases a complex chain of molecular
events may result in the expression of
bacteriophage encoded toxin genes or virulence
factors. These have a direct effect, causing the
symptoms of diseases such as diphtheria,
cholera, dysentery, botulism, necrotizing
pneumonia, toxic shock, food poisoning and
scarlet fever. We have focused on the
pathogenic bacterium Streptococcus pyogenes
SF370 and its associated Siphovirida prophage
SF370.1. At prophage induction a protein toxin
called SpeC is expressed, which cross links
antigen-presenting cells with T-cell receptors.
This stimulates a large immune response
resulting in the symptoms of scarlet fever and in
some cases causes toxic shock. We aim to
structurally characterise every protein in the
SF370.1 prophage genome using a combination
of X-ray crystallography techniques and cryo-
electron microscopy. Techniques routinely used:
Gene cloning, mutagenesis, protein expression,
biochemical assays and structural biology (X-ray
crystallography).

Prof Peter Williams

Science and Technology, Glyndwr
University

Current Role & Research Activities: Director of
the Materials Science Research Centre at
Glyndwr University. Current research activities
are concerned with the extraction, chemical and
physicochemical characterisation, chemical and
physical modification, functional properties and
applications of biopolymer materials and in
particular polysaccharides. Our proposal will be
concerned with the chemical modification of
fructans extracted from grass to produce
materials that can be used as thickeners and
dispersing agents in a broad range of industrial
sectors.

IBTI CLUB CONTACTS

BBSRC

Main Contact

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EPSRC

Clare Bumphrey

Physical Sciences Portfolio Manager

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