

# Science+ Innovation

Institute of Food Research

Issue 2:08

## Institute Update

### Successfully connected

### Outstanding science

We are making leading contributions to the understanding of food and disease prevention, with multidisciplinary approaches combining studies of basic cellular function through to insights from trials with human volunteers. Work continues that is not only leading edge in molecular microbiology and modelling, but also responsive to industry needs. Substantial funding from BBSRC, DEFRA and other agencies will support new ventures, putting science into practice.



Network theory has far reaching applications in a wide range of disciplines. The annual world gathering on the topic, NetSci, was held outside the USA for the first time this year. **NetSci08** - organised by József Baranyi with Research Park colleagues - attracted 250 researchers from 26 countries.

**Albert-László Barabási**  
(Northeastern University, Boston, USA)  
"Just want to say thank you for the fantastic event that you put together in

Norwich - everything from the big picture - sessions, speakers - to the smallest details, like food and laptop access, was truly outstanding, and your hospitality was exemplary."

**Alex Vespignani**  
(University of Indiana, Bloomington, USA)  
"This conference was the best of the Netsci series so far and you have definitely raised the bar for your successor-organisers."  
[www.ifr.ac.uk/netsci08/](http://www.ifr.ac.uk/netsci08/)



### Driving economic and social impact

Mike Peck was one of IFR's representatives at the BBSRC's 'Bioscience: Biomillions' event for industry, business and policy makers in London. Recognising his outstanding contribution to the Institute and the international effort the science of *Clostridium botulinum*, with a level of responsibility that would have fatal consequences for poor advice, Mike has recently been awarded a Personal Merit Promotion (PMP) to Band G.

Tim Brocklehurst has made very important and distinctive contributions to IFR's knowledge transfer and industry interactions in microbiology, reflected in a PMP to Band F. Also promoted to Band F is Paul Finglas, who has widely recognised expertise in food nutrients and has built up an impressive network of relationships with stakeholders that are important to IFR as a whole, including FSA, EC, EFSA, CEN, FAO/WHO and the food industry.

'Science+Innovation' is published 3 times a year and is available via e-mail, from our website [ifr.ac.uk](http://ifr.ac.uk) and in print format. It reflects our science discoveries, and demonstrates our economic impact. The newsletter addresses a wide stakeholder-base.

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A vital link in the food chain

[ifr.ac.uk](http://ifr.ac.uk)

# Designer diet for prostate cancer

Prostate cancer is the most common non-skin cancer for males in western countries. For the first time, a research team led by Richard Mithen at IFR has provided an explanation of how eating broccoli might reduce cancer risk based upon studies in men, as opposed to trying to extrapolate from animal models. They have provided an insight into why eating broccoli can help men stay healthy.

Men at risk of developing prostate cancer ate either 400g of broccoli or 400g of peas per week in addition to their normal diet over 12 months and the team found that there were more changes in gene expression in men on the broccoli-rich diet than on the pea diet; these changes may be associated with the reduction in the risk of developing cancer, already reported in epidemiological studies.

Previous studies have suggested that the fifty percent of the population who have a GSTM1 gene gain more benefit from eating broccoli than those who lack this gene. This new work shows that the presence of the GSTM1 gene had a profound effect on the changes in gene expression caused by eating broccoli.

The results of this pilot study suggest that relatively low amounts of cruciferous vegetables in the diet – a few portions per week – can have large effects on gene expression by changing cell signalling pathways. These signalling pathways are the routes by which information is transmitted through a molecular cascade which amplifies the signal to the nucleus of the cell where gene expression occurs.

**Publication:** Maria Traka *et al.* (2008) Broccoli consumption interacts with *GSTM1* to perturb oncogenic signalling pathways in the prostate. PLoS One <http://www.plosone.org/doi/pone.0002568>

**Funding:** BBSRC Core Strategic Grant

**Collaboration:** Universities of East Anglia & Nottingham, The Sainsbury Laboratory, Norwich and N & N University Hospital

The team are currently planning a larger study with men with localised prostate cancer, and will compare the activity of standard broccoli with their special variety of high glucosinolate broccoli, developed at the John Innes Centre, and then licensed to Seminis Inc for commercialisation by PBL

Professor Mithen comments:

*“Other fruits and vegetables have been shown to also reduce the risk of prostate cancer and are likely to act through other mechanisms. Once we understand these, we can provide much better dietary advice in which specific combinations of fruit and vegetable are likely to be particularly beneficial. Until then, eating two or three portions of cruciferous vegetables per week, and maybe a few more if you lack the GSTM1 gene, should be encouraged”.*

About 300 mainstream and specialist news outlets have so far published stories about the team's work, following a scientific press release about the paper. News has reached as far afield as ABC and CBS News in the USA, outlets in South Africa, Australia, the Middle and Far East, and nearer home in France, Germany and the UK.





# Hayfever HOPE

In the first human study of its kind, Claudio Nicoletti and his team have found that probiotic bacteria in a daily drink can modify the immune system's response to grass pollen, a common cause of seasonal hay fever.

Hayfever is an allergic reaction to pollen or fungal spores, most commonly grass pollen. The immune system mistakes the spores for harmful invaders and produces excessive amounts of the antibody IgE to bind to them and fight them off. IgE stimulates the release of histamine to flush out the spores, and this irritates the airways making them swell and producing the symptoms of hayfever.

Volunteers with a history of seasonal hay fever drank a probiotic drink containing *Lactobacillus casei* daily over 5 months. There were no significant differences in levels of IgE in the blood between the two groups at the start of the study, but IgE levels were lower in the probiotic group both at the peak season and afterwards. At the same times, levels of

the antibody IgG were higher – IgG is a type of antibody that in contrast to IgE is thought to play a protective role against allergic reactions.

The next stage for the IFR team is to perform a similar study to see if the immunological changes translate into a real reduction in the clinical symptoms of hayfever and to examine the mechanisms involved.

**Publications:** Kamal Ivory *et al.* (2008) Oral delivery of *Lactobacillus casei* Shirota modifies allergen-induced immune responses in allergic rhinitis. *Clinical & Experimental Allergy* **6** 1-8; Claudio Nicoletti (2008 in press) Possible use of probiotics as modulators of allergic disease. *International Journal of Probiotics & Prebiotics* **3**

**Funding:** Yakult and BBSRC Core Strategic Grant



## Fish fat find

Oesophageal cancer rates are increasing faster than any other malignancy. The prognosis for patients is poor as it is usually diagnosed at an advanced stage - average survival time is less than a year. Far better, then, to find ways to prevent it developing. A high consumption of fish is associated in some studies with a reduced risk of oesophageal cancer.

Most oesophageal cancers arise from a condition called Barrett's esophagus. The enzyme cyclo-oxygenase (COX)-2 is upregulated in both Barrett's esophagus and oesophageal cancer. The focus of a number of trials is therefore to inhibit COX-2. Ian Johnson and Liz Lund, in collaboration with the Norfolk and Norwich University Hospital, have discovered that supplementation with the n-3 fatty acid eicosapentaenoic acid (EPA) over six months significantly decreased COX-2 levels in Barrett's esophagus patients. There was no clear evidence that EPA had any effect on cell proliferation, another pre-cancerous change, but it is difficult to measure proliferation in Barrett's biopsies.

A higher or more prolonged level of supplementation may have a role to play

in correcting pre-cancerous changes in cells and tissues. The results provide a good reason for further studies into the anticancer effects of fish oils.

**Publication:** Sam Mehta *et al.* (2008) Effect of n-3 polyunsaturated fatty acids on Barrett's epithelium in the human lower esophagus. *American Journal of Clinical Nutrition* **8.7** 949-956

**Funding:** BBSRC Core Strategic Grant with support from the NHS and SLA Pharma

# Enzyme evolution

Tony Michael's expertise in genome analyses, bioinformatics and evolutionary analysis contributed to a Canadian-American-British collaboration that has published the first crystal structure of a key metabolic enzyme, the human spermine synthase. Analysis of the structure has revealed a new paradigm in enzyme evolution.

Why are spermine synthase and spermine important? Well, if you are a male it is self-evident, and we wouldn't have sperm without it. Crystals of spermine were first observed by Anton van Leeuwenhoe in 1678. If you are female or male, spermine gates NMDA receptors in the brain and potassium channels; genetic defects in spermine synthase lead to severe mental retardation, to seizures and to multiple problems with neuro-development.

There is an N-terminal extension in the spermine synthases of animals that is not present in fungi, plants or in unicellular eukaryotes. There is no sequence homology between the N-terminal extension and anything else but the structure clearly shows that this extension has evolved from the enzyme S-adenosylmethionine decarboxylase, which provides the substrate for

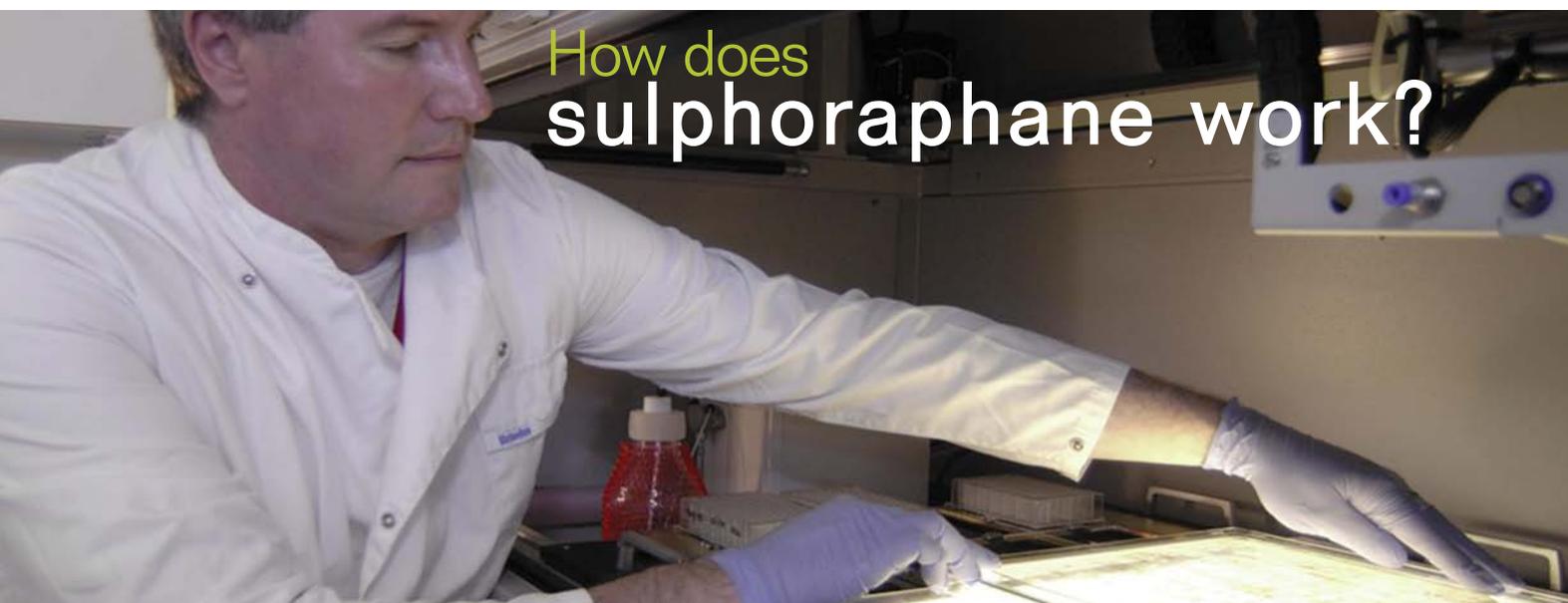
spermine synthase. However, the N-terminal extension does not retain the catalytic activity of S-adenosylmethionine decarboxylase but is essential for the catalytic activity of spermine synthase. Evolutionary analysis shows that the new enzyme fusion arose in the *Choanoflagellida*, single-celled animals that are the closest relatives of multicellular animals.

**Publication:** Hong Wu *et al.* (2008) Crystal structure of human spermine synthase: implications of substrate-binding and catalytic mechanism. *Journal of Biological Chemistry* **283**(23)16135-16146

This paper was selected as a 'Paper of the Week' in JBC Online in April 2008.

**Collaboration:** University of Toronto, Pennsylvania State University College

**Funding:** Structural Genomics Consortium (reg charity no 1097737), US Public Health Services



## How does sulphoraphane work?

Fran Mulholland

Sulphoraphane (a chemical found in cruciferous vegetables) is a potent cancer preventive agent but its multiple mechanisms of action are not fully understood. Fran Mulholland's proteomics expertise at IFR was crucial in collaborative work with the University of East Anglia which has shown for the first time that it down-regulates the expression of three serotonin receptors, and decreases SERT protein expression levels in colon cancer Caco-2 cells. Serotonin regulates gastrointestinal motility and epithelial function, and results suggest a potential effect on serotonin release. This new understanding may help in elucidating signalling pathways in colon cancer and lead to development of novel therapeutic agents.

**Publication:** Lina Mastrangelo *et al.* (2008) Serotonin receptors, novel targets of sulforaphane identified by proteomic analysis in Caco-2 Cells. *Cancer Research* **68** 5487-5491

**Funding:** Cancer Prevention Research Trust, EU Framework 6 'Cancerdegradome' project and a PHD studentship at UEA

# 'Addicted'

## cells provide early cancer diagnosis

Ian Johnson's team at IFR have detected subtle changes that may make the bowel more vulnerable to the development of tumours. They looked at changes in 18 genes that play a role in the very earliest stages of colorectal cancer, and detected clear chemical differences in these genes in otherwise normal tissue in cancer patients. This represents a new way to identify defects that could eventually lead to cancer.



Nigel Belshaw, who led the research

All cells carry a complete set of instructions for the whole organism in their nuclear DNA, but to define the specialised structure and functions of each particular cell type, genes must be switched on or firmly off, over the course of the cell's life-cycle.

One of the mechanisms controlling the activities of the genes in a cell is the "epigenetic code", a set of chemical tags attached to the DNA molecule, marking individual genes for expression, or for silence. It is well known that the abnormal behaviour of cancer cells is partly due to mistakes in this epigenetic code, some of which switch on genes for growth, whilst others switch off genes that would otherwise cause abnormal cells to destroy themselves.

They are exploring the possibility that such mistakes in the epigenetic code may begin to occur in apparently normal tissues, long before the appearance of a tumour, and have investigated the numbers of methyl groups attached to DNA taken from the cells lining the large intestine of bowel cancer patients. They found subtle changes that may make the whole surface of the bowel more vulnerable to the eventual development of tumours by causing the 'addiction' of cells to abnormal gene expression.

Some of these changes seem to occur naturally with age, but we are investigating the possibility that factors in our lifestyle such as diet, obesity and exercise can accelerate or delay DNA methylation as we grow older, thus giving us some degree of control over this vital aspect of our long-term

*"Basic research in the relatively young field of epigenetics is already contributing to our understanding of human health. Understanding how epigenetic processes work to maintain healthy cells and tissues is the key to long-term health because, as we see here, the breakdown of these normal processes may subsequently cause disease."*

*Professor Nigel Brown, Director of Science and Technology at BBSRC*

**Publication:** Nigel Belshaw *et al.* (2008) Profiling CpG island field-methylation in both morphologically normal and neoplastic human colonic mucosa. *British Journal of Cancer* **99** 136-142

**Funding:** BBSRC Core Strategic Grant & Food Standards Agency

# Oranges 'juiced'

**Publication:** Gary Brett *et al.* (2008) Absorption, metabolism and excretion of flavanones from single portions of orange fruit and juice and effects of anthropometric variables and contraceptive pill use on flavanone excretion. *British Journal of Nutrition* (in press)

**Funding:** Food Standards Agency

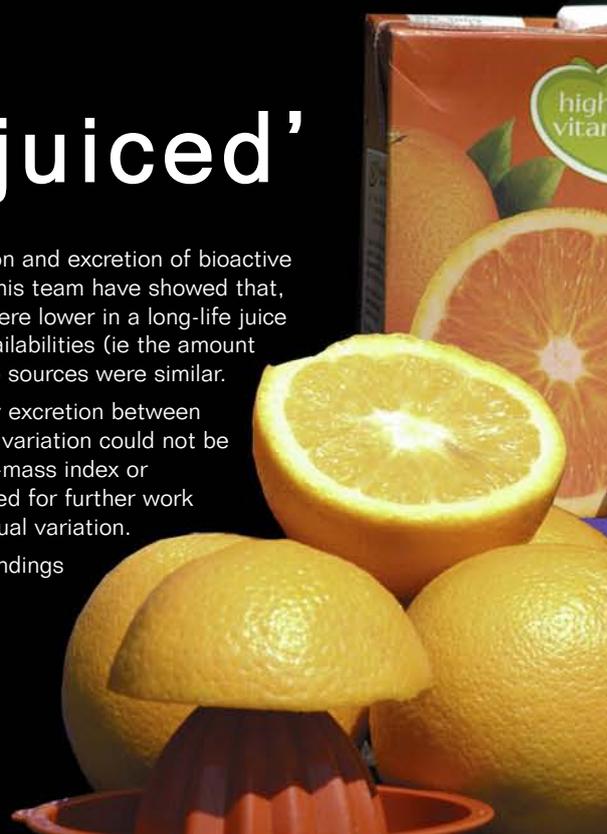
**Collaboration:** University of Texas at Austin, USA

In work designed to examine the absorption and excretion of bioactive flavanones from oranges, Paul Kroon and his team have showed that, although the levels of these compounds were lower in a long-life juice compared to fresh fruit, the relative bioavailabilities (ie the amount absorbed, adjusted for dose) from the two sources were similar.

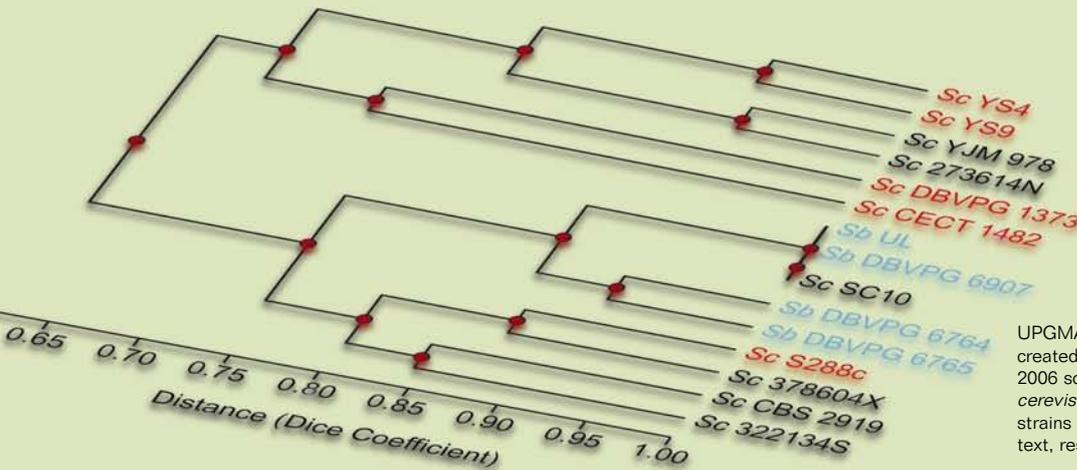
Although the variation in flavanone urinary excretion between individual people was extremely large, the variation could not be explained by differences in age, sex, body-mass index or contraceptive pill use. This highlights a need for further work to establish the source of this inter-individual variation.

Paul Kroon was invited to present these findings at the 24th International Conference on Polyphenols

[www.polyphenols2008.com](http://www.polyphenols2008.com) organised by the international society 'Groupe Polyphenols' and held in July 2008.



# Are clinical isolates of *Saccharomyces cerevisiae* food- and drink-related?



UPGMA dendrogram of yeast AFLP patterns created using TotalLab TL120 Trace version 2006 software. *Sb*, *S. boulardii*; *Sc*, *S. cerevisiae*. Clinical, probiotic and non-medical strains are indicated in black, blue and red text, respectively (reproduced with permission)

The yeast *Saccharomyces cerevisiae* has been used for thousands of years in the fermentation of food and drink. In the last 10-20 years, there has been an upturn in the incidence of infections linked to this yeast. Staff in the National Collection of Yeast Cultures, housed at IFR, have led the first combined genetic and metabolomic analysis of a group of medically-important and non-medical *Saccharomyces* strains.

*Saccharomyces cerevisiae* and *Saccharomyces boulardii* are now regarded as emerging pathogens in patients who are immunocompromised or are already extremely debilitated, with the ability to colonise the human respiratory and gastrointestinal tracts and even cause systemic fungaemia. The origins of the clinical isolates are open to debate but there is increasing evidence that some are food-related, with particular suspicion falling on *S. boulardii* which is used world-wide as an alternative therapy to combat antibiotic-associated diarrhoea and *Clostridium difficile* infection.

Metabolomics (the systematic study of the unique chemical fingerprints that result from specific biochemical pathways) proved to be a valuable taxonomic tool in the research, and could be used to investigate anomalies

between genotype and phenotype. Overall, the collaborative team were able to confirm the link between some (though not all) clinical isolates and baking or probiotic strains. Their work confirms that *S. cerevisiae* and *S. boulardii* are members of the same species and suggests separate origins for different clinical *Saccharomyces* strains, with a food-related source being a high probability.

**Publication:** Donald MacKenzie *et al.* (2008) Relatedness of medically important strains of *Saccharomyces cerevisiae* as revealed by phylogenetics and metabolomics. *Yeast* **25** 501-512

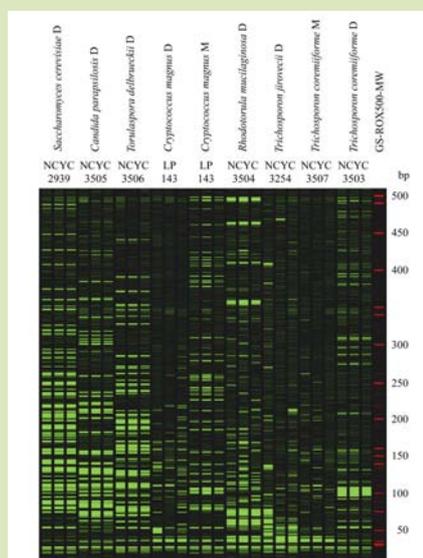
**Funding:** BBSRC Core Strategic Grant, Leonardo da Vinci Practical Training Award, BBSRC and EPSRC funding to the Manchester Centre for Integrative Systems Biology

**Collaboration:** University of Manchester; Universidad de Extremadura, Spain; University of Applied Sciences, Jena, Germany

## Which kit for extracting yeast DNA?

**Publication:** Linda Fuller *et al.* (2008) Species-specific variation in efficacy of yeast genomic DNA isolation techniques assessed using AFLP. *Analytical Biochemistry* 10.1016/j.ab.2008.06.021

**Funding:** BBSRC Core Strategic Grant and DEFRA-LINK grant FQS37



NCYC staff have checked three different commercial DNA extraction kits for efficacy in isolating genomic DNA from a broad range of yeast species. Using DNeasy® (Qiagen) they extracted sufficient DNA to generate reproducible AFLP patterns from 66, mainly ascomycetous, strains out of a total of 79 different yeasts. Problematic species (typically pigmented or high polysaccharide producers) were tackled using MasterPure™ (Epicentre Biotechnologies) or Y-DER™ (Pierce), with good results. Using their results researchers can now optimise selection of genomic DNA isolation methods for particular yeast species.

Fluorescent AFLP patterns from yeast strains (image created using Genographer v1.6.0 software (reproduced with permission))

# Social science impacts on communication

IFR's Gene Rowe has an established international reputation in evaluation methodology. His collaboration with communications professionals at IFR is providing a rigorous underpinning to practical activity.

## Evaluation – could do better?

Many policy-makers and academics have come to the view that involving the public in policy setting and decision-making (or “public engagement”) is desirable. But is it actually beneficial?

The theorised benefits of engagement (over traditional approaches) include more satisfactory and easier decisions, greater trust in decision-makers, and the enhancement of public and organisational knowledge. Empirical support for these advantages is, however, scant. Engagement processes are rarely evaluated and, when they are, the quality of evidence is generally poor.

Gene Rowe and colleagues developed a normative framework for evaluating engagement processes as part of the evaluation of a major UK public engagement initiative: the 2003 ‘GM Nation?’ debate. They subsequently

assessed the validity of the framework itself and the instruments they developed to operationalise it. The results from this analysis will be useful for both academics and practitioners, helping to inform the design and conduct of better engagement exercises as well as better evaluation.

**Publication:** Gene Rowe *et al.* (2008) Analysis of a normative framework for evaluating public engagement exercises: Reliability, validity and limitations. *Public Understanding of Science* (2008 in press)

**Funding:** Leverhulme Trust - Programme on Understanding Risk

**Collaboration:** Universities of East Anglia & Cardiff

## Research priority setting – how can the public have a say?

One area where increased engagement might serve a function, and which is of contemporary concern in the UK (and more widely), is that of *research funding* decisions, as taxpayers ultimately fund much of national science.

Communications staff and social scientists at IFR have teamed up to test a particular engagement approach and to assess the criteria used by public representatives in order to make their decisions.

In 2007, as part of the ‘IFRintheCity’ series, members of the public in Norwich were asked to select which of four potential projects (about food-related topics, presented by scientists) ought to be funded. The aim of the study was twofold: to trial and evaluate a method of engaging with the public about science, and to study the factors used by the public in making funding allocation decisions. Results suggest that, while participants enjoyed the process and appeared to learn from it, they were not particularly

‘representative’ - a common problem with engagement approaches of this type. Participants’ funding decisions were largely based on factors such as ‘benefit to society’ and ‘personal relevance’, though aspects such as the ‘likeability’ and ‘trustworthiness’ of the speaker may have played a role. We hope as a result of this work to ultimately provide a template for use in the assessment of public engagement events more generally, but specifically with regards to the issue of research funding. Our approach has been taken up in Australia, where Masters student Cobi Smith will be repeating the event (and evaluation) in Adelaide and Canberra during Australian Science Week.

**Publication:** Gene Rowe *et al.* (2008 in press) Public engagement in research funding: A study of public capabilities and engagement methodology. *Public Understanding of Science*

**Funding:** BBSRC Core Strategic Grant

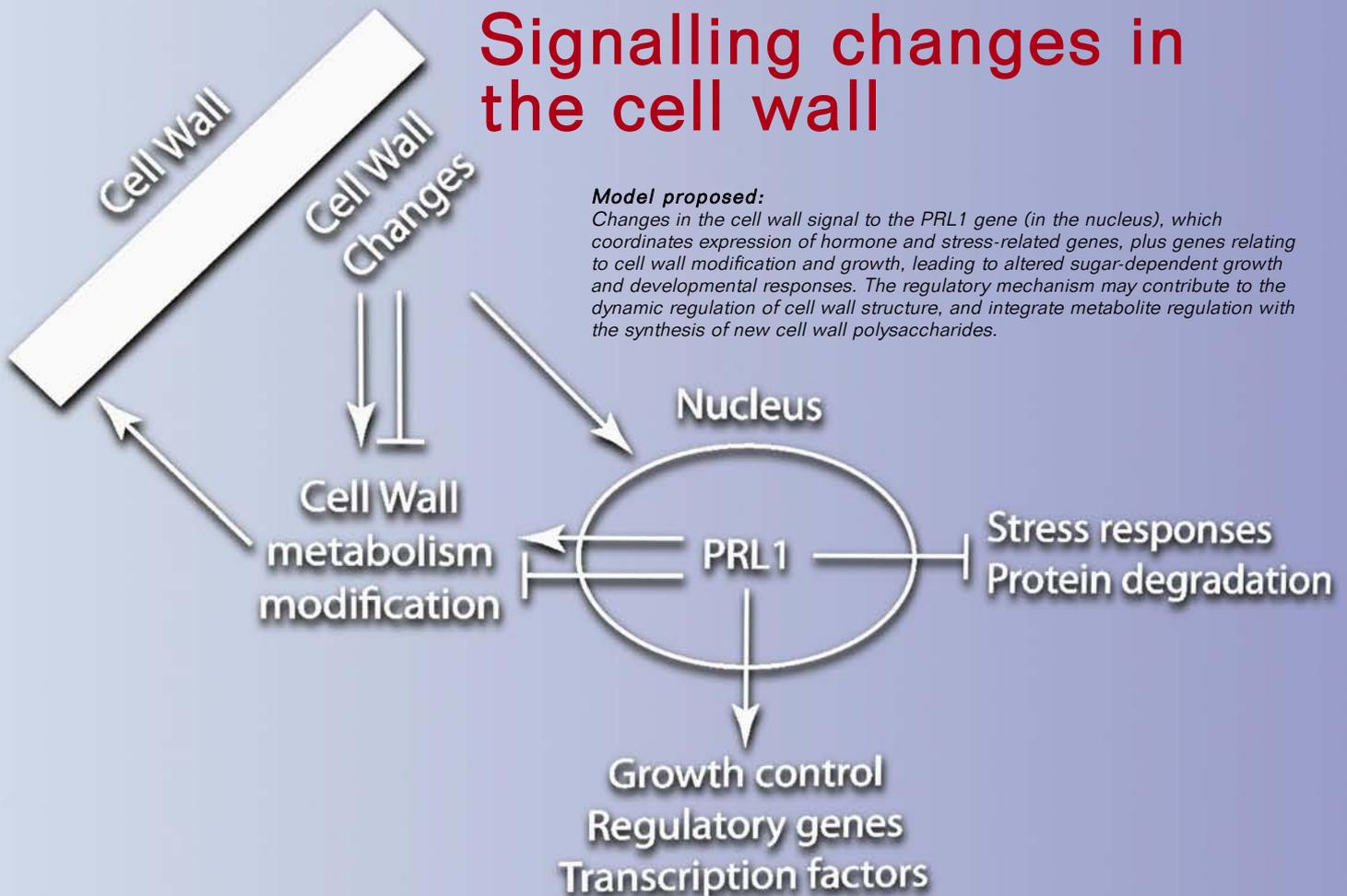


## From fundamental... into practice

Keith Waldron leads the 'Sustainability of the Food Chain' Exploitation Platform, which is developing greater understanding of how to disassemble plant structures using combination approaches (biochemical, chemical and physical) for selectively extracting and modifying cell-wall and intracellular components.

The team's aim is to enable total transformation of food-processing-derived co-products (for example vegetable trimmings and cereal co-products such as brewers' spent grain) into high- and medium-added value food, feed and related ingredients such as biopolymers, phytochemicals, nutrients and micronutrients.

## Signalling changes in the cell wall



Cell wall materials represent the major carbohydrate component in most plants. Understanding how plant cell wall composition is controlled is highly relevant because of the potential for converting cell wall material to biofuels and chemical feedstocks. A major BBSRC research objective in this area is to alter cell wall composition in biomass crops such as rapidly growing willow, poplar and perennial grasses.

Recent research has identified genes encoding enzymes involved in synthesising different cell wall components, but many other aspects of cell wall function and organisation are not well understood.

Norwich Research Park collaboration involving Keith Waldron and colleagues has resulted in the description of several mutants in genes encoding enzymes synthesising sugars destined for incorporation into cell wall polysaccharides.

The mutants exhibit strong sugar-dependent growth and developmental phenotypes in the dark, and elevated starch levels. These phenotypes

require a well characterised protein involved in regulating sugar, hormone and light responses. They also showed that changes in cell wall structure and composition are most likely responsible for the observed phenotypes.

**Signalling changes in the cell wall**  
Li, Y. *et al.* (2007) Cell wall composition changes caused by *hsr8/mur4* mutations activate PRL1-dependent sugar responses in *Arabidopsis thaliana*. *The Plant Cell* **19** 2500-2515

**Funding:** BBSRC grant and BBSRC Core Strategic Grant

**Collaboration:** John Innes Centre and University of East Anglia, UK

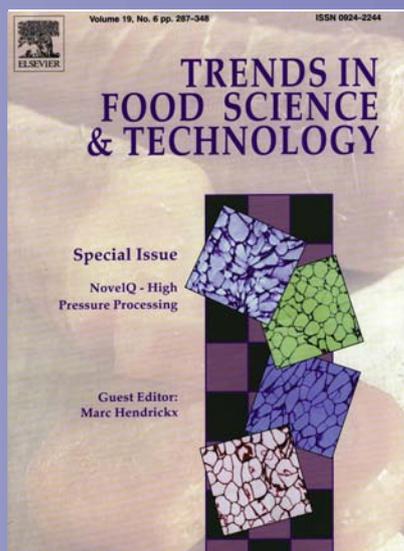
## DISCO means discovery

Keith Waldron and his team at IFR are heavily involved a new EU project, 'DISCO' – the targeted discovery of novel cellulases and hemicellulases and their reaction mechanisms for hydrolysis of lignocellulosic biomass.

Coordinated by VTT in Finland, the aim is to enable sustainable energy and chemical production from renewable sources. Solutions can lead to improved security of energy supply and chemical production, and reduction of environmental impacts, especially climate change.

## Setting the scene in NovelQ

A special issue of 'Trends in Food Science & Technology' (2008) 19 [6] has been published which details the 'state of the art' in high pressure processing at the start of NovelQ. This Framework VI project brings together acknowledged European expertise in science and technology to address innovations in novel processing and packaging. IFR scientists are well-represented in the project and have co-authored two of the six review articles.



## Bringing the biofuel markets together

Keith Waldron was a speaker at the recent, inaugural London Biofuels Conference, and in Barcelona at ESOF.

## 2nd generation biofuels expertise



The 'Sustainability of the Food Chain' Exploitation Platform is a founder member of the British Bioalcohols Group, which aims to exploit agri-food-chain biomass such as wheat or oilseed rape straw for the production of second generation bioalcohols.

[www.britishbioalcoholsgroup.nrp.org.uk](http://www.britishbioalcoholsgroup.nrp.org.uk) *PhD student, Adam Elliston*

## Achor: IFR Studentship

The technical, environmental and social science consultancy Achor, has combined forces with the team to fund a PhD studentship on 'Exploitation of food processing and related waste streams in the production of bioalcohols'.

[www.achor.co.uk](http://www.achor.co.uk)



## Taking up the future energy challenge

The IFR team are supporting the University of East Anglia's £5 million initiative to bring together a number of activities in the new Norwich Laboratories (NEL), to be launched formally in January 2009. There are two main strands of research being undertaken: finding novel ways of producing energy - including improving solar energy and harnessing hydrogen – and the quest for more sustainable second generation biofuels, concentrating on the waste products from food crops.

NEL will also serve as a training ground for a new generation of scientists who will be studying on a newly launched MSc programme in 'Biotechnology for a Sustainable Future', in which they will receive practical training in a number of aspects of the science that underpins bioenergy.

Funding for the Norwich Energy Laboratories and work to be carried out in them has come from a number of sources including BBSRC and DEFRA.



Total Food 2009 (22 – 24 April, 2009), organised by IFR under the auspices of the Royal Society of Chemistry Food Group, is the third in a series of biennial international conferences which focus on the sustainable exploitation of agri-food co-products and related biomass, thereby helping to minimise waste. The event will highlight recent developments and facilitate knowledge transfer between the agri-food industries, scientific research community, legal experts on food-related legislation and waste management, and consumer organisations. With an expected participation of 250 – 400 delegates from both industry and research sectors, the conference will comprise plenary lectures, short talks, poster sessions, and focussed workshops. Proceedings will be published.

[www.ifr.ac.uk/totalfood2009](http://www.ifr.ac.uk/totalfood2009)

# Dairy Products

*Listeria monocytogenes* is a foodborne pathogen of major concern to the food industry. Developing an antilisterial dairy starter, adjunct or bioprotective culture is an attractive route to increase safety in dairy products.

*Listeria monocytogenes* is a foodborne pathogen of major concern to the food industry. Developing an antilisterial dairy starter, adjunct or bioprotective culture is an attractive route to increase safety in dairy products.

Pediocin PA-1 is an antilisterial bacteriocin with a broad inhibitory spectrum. We have already achieved pediocin PA-1 production in naturally pediocin PA-1 resistant *Lactococcus lactis*. Spanish collaborators have confirmed activity against food-poisoning bacteria in cheese-making. But resistance and immunity to a bacteriocin are not equivalent properties and the most recent step has been to demonstrate that including

the pediocin PA-1 immunity gene (*pedB*) leads to a significant increase in production of pediocin.

Work is in progress to investigate the efficacy of this system in wild *L. lactis* strains when they are added as adjunct cultures for the control of undesirable microorganisms in cheese ripening.

**Publication:** Juan Arqués *et al.* Immunity gene *pedB* enhances production of pediocin PA-1 in naturally-resistant *Lactococcus lactis* strains (2008) *Journal of Dairy Science* **91** 2591-2594

**Funding:** AGL2002-04609-CO2-02 from the Comisión Interministerial de Ciencia y Tecnología, Ministerio de Educación y Ciencia, and BBSRC Core Strategic Grant

**Collaboration:** Universidad Complutense, Madrid

# Meat

*Clostridium perfringens* type A is a significant cause of food poisoning. Spores are commonly found in meat and poultry, albeit at a low concentration, and this pathogen is a particular problem when cooked foods are subject to inadequate cooling. The main concern is bulk meats cooked in large batches.

IFR's new dynamic predictive model and Perfringens Predictor will contribute to a reduction in the food poisoning incidence associated with *C. perfringens*.



**Publication:** Yvan le Marc *et al.* (2008 in press) Modelling the growth of *Clostridium perfringens* during the cooling of bulk meat. *International Journal of Food Microbiology*

**Funding:** Food Standards Agency (Projects B14009 and B13005)

**Collaboration:** Universidad Politécnica de Cartagena and colleagues in the food industry

A dynamic predictive model has been developed by IFR microbiologists and mathematical modellers to describe the effects of temperature, pH and NaCl concentration on the growth of *Clostridium perfringens* type A. The model for the specific growth rate was based on 81 growth curves generated at IFR, or obtained from the publicly available, ComBase database. Growth curves obtained during cooling were fitted with the dynamic model of Baranyi and Roberts. This made it possible to determine the parameter value reflecting the physiological state of *C. perfringens* after heating profiles typically applied to bulk meat. The model with the obtained parameters provided a good description of growth of *C. perfringens* in 24 heating/cooling curves generated specifically for this work (various non-isothermal treatments with a range of combinations of pH and NaCl concentration), and also for existing literature data.

The dynamic model has been implemented in the IFR-developed Perfringens Predictor, a web-based application that can be accessed free of charge via [www.combase.cc](http://www.combase.cc)

# BAGELS project fortifies bread with selenium



(L to R) Martin Broadley (Nottingham), Mark Tucker (Yara UK Ltd), Steve McGrath (Rothamsted Research), Dave Hart (IFR) and Mark Meacham (Nottingham) celebrate the success of the BAGELS project at the Cereals UK event.

IFR's Dave Hart is contributing to a DEFRA-funded project on biofortification through the Sustainable Arable LINK programme. 'BAGELS' was instigated to find out whether selenium levels in UK-grown wheat could be increased safely by using selenium-containing fertilisers.

The fate of the selenium has been determined all the way through the food

chain with Dave, along with colleagues from the University of East Anglia, providing measurements of selenium levels and chemical forms in grain and flour fractions and in bread products. Results confirm that the concept of 'agronomic biofortification' works in practice.

<http://bagels.ukcrop.net>

The analysis of the selenium (and some other trace elements) was carried out using an Inductively Coupled Plasma Mass Spectrometer (ICP/MS), which is capable of measuring most trace elements to parts per billion levels. The Atomic Absorption Spectrophotometer is capable of measuring a range of trace elements at part per million levels. Analyses using either technique is available via IFR Extra.



## What's in your bun?

It may seem prosaic, but data on the nutritional composition of biscuits, buns, cakes and pastries commonly consumed in the UK is urgently needed to update the nutrient databanks that support national dietary surveys and the UK food composition tables, McCance and Widdowson's *The Composition of Foods*. Data collected at IFR will be evaluated by comparison with existing UK food composition data and data from other sources (e.g. industry, other food composition datasets) and quality assessed, using the new guidelines from the IFR-led EU project EuroFIR for data quality assessment.

## Expertise in demand



# Can compounds in chocolate reduce heart disease risk?

Despite postmenopausal women being at a similar risk to men for developing cardiovascular disease, they are under-represented in clinical trials. IFR scientists are supporting a University of East Anglia-led clinical trial in which postmenopausal women with type 2 diabetes will eat a specially formulated high-flavonoid and soy protein/isoflavone supplemented chocolate, to test whether these compounds provide additional protection from heart disease over and above that provided by conventional drugs. If the trial confirms this, it could have a far-reaching impact on the advice given to postmenopausal women who have type 2 diabetes.

# Almonds

## - a possible source of prebiotic functional food?

**Publication:** Giusy Mandalari *et al.*  
Potential prebiotic properties of Almond  
(*Amygdalus communis* L.) seeds (2008)  
Applied & Environmental  
Microbiology **74** 4264 - 4270

**Funding:** Almond Board of California

A project jointly led by Arjan Narbad and Martin Wickham, combining IFR's skills in colonic microbial fermentation (colon model) and in simulation of human gastric and duodenal digestion (Model Gut Platform), has established the beneficial effect of almond fractions. One of the post-duodenal digests was able to preferentially increase the growth of beneficial bacteria with a prebiotic index

(a relative indication of the prebiotic potential) of 4.43. This compares well with the value of 4.08 obtained with a commercial prebiotic fructooligosaccharide product.

More detailed studies on the digestibility of almonds and the role played by lipids in the potential prebiotic effect need to be performed with human volunteers.





Nicola Woodward

## A novel approach to reducing fat consumption

In response to concerns about obesity industry has developed successful low-fat and reduced-fat products that are acceptable to consumers, but the impact of these products can be impaired due to over-consumption. There is evidence that delaying the digestion of fats can initiate signals that suppress appetite, induce satiety and reduce further consumption of fat-based foods. A novel approach is to achieve this by physically modifying the detailed molecular structure of processed foods.

BBSRC are funding Vic Morris, Pete Wilde and Nicola Woodward to investigate the effects of rationally-modified interfacial structures on lipolysis for processed food emulsions, and they will be generating protein networks or skins designed to resist displacement by bile salts or other biosurfactants secreted by the body, in order to test this novel approach.

## Nutritional aspects of emulsified foods

Alan Mackie and colleagues have been collaborating with VTT in Finland to examine the mechanism by which enzymatically cross-linked Na caseinate is protected from *in vitro* gastric and duodenal digestion. The team have shown that digestion is delayed when the protein is cross-linked in the presence of emulsified triglyceride. Rates of digestion are difficult to measure because of the problems of quantification especially by SDS-PAGE. However, they have used a combination of SDS-PAGE and SEC to show that whilst rates of digestion of cross-linked protein in solution are slightly slowed from the non-cross-linked control, there are more significant differences with adsorbed proteins.

## Targetting information on *Campylobacter* risk

Pradeep Malakar and Gary Barker have probabilistically modelled *Campylobacter* infection and illness resulting from undercooking poultry products in the home environment with information sourced from publicly available databases and literature. Sensitivity analysis of the model indicates that consumer knowledge of cooking chicken determines the risk of *Campylobacter* infection and illness.

Model calculations show that it is possible to eliminate this route of infection by

consistent monitoring of cooking temperatures and ensuring that a core temperature of 70° C is reached during the cooking process and held for more than 2 minutes. As more than half the meals where chicken is the main ingredient are still prepared at home, targeted information on domestic preparation and cooking chicken will help to decrease the *Campylobacter* burden of illness from undercooking such products in England and Wales.

**Publication:** Pradeep Malakar and Gary Barker (2008) Estimating *Campylobacter* burden of illness from undercooking poultry products in England and Wales. The Open Food Science Journal 2 57-61 doi: 10.2174/1874256400802010057

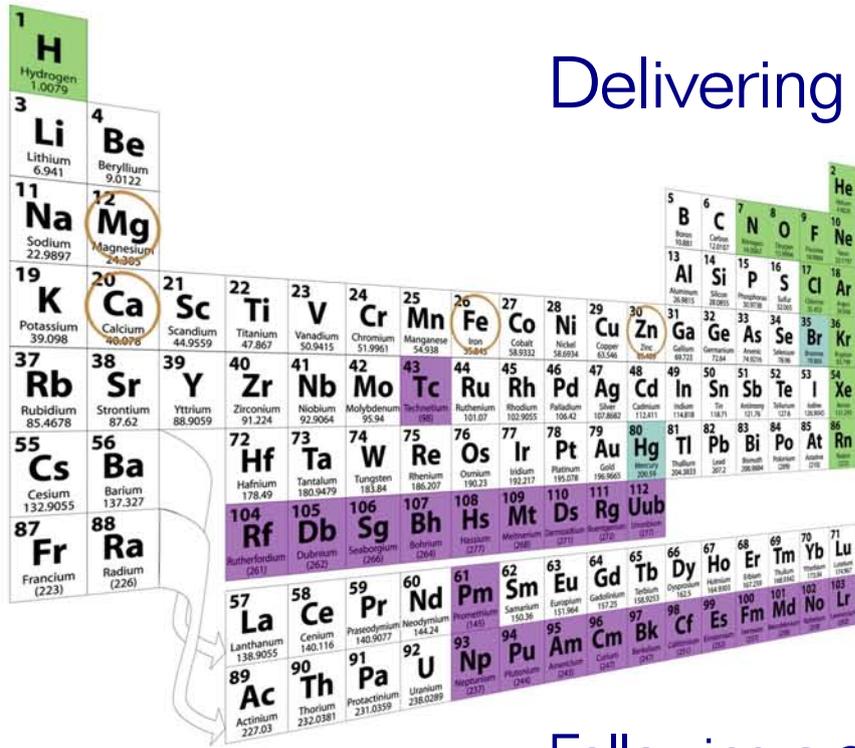
**Funding:** UK Rural Economy & Land Use Programme (RELU)



## Transferable skills in utilising databases

IFR recently hosted a database workshop as part of the EU project BIOTRACER. Delegates attended from several countries, including Slovakia, Austria, Denmark, Romania, the Netherlands and the UK; course material, Open Source software tools and databases used in the workshop were all provided on DVD and a dedicated web forum was established for support/discussion after the workshop was finished. [www.biotracer.org/](http://www.biotracer.org/)

# Delivering beneficial components



The intake of many minerals and vitamins has fallen in recent years. If it is possible to design a system that will protect the mineral during processing, storage and the early stages of digestion we should be able to enhance mineral uptake.

Roger Parker and Pete Wilde have received funding from the BBSRC Diet and Health Research Industry Club to develop smart, environmentally responsive encapsulation and delivery systems for water-soluble minerals, to improve the efficiency of absorption of mineral fortificants such as iron, zinc, calcium and magnesium.

Their hypothesis is that if iron can be delivered to the duodenum in a soluble protected form, uptake will be enhanced as there will be less opportunity for the iron to form complexes or to oxidise.

## Following a signalling hypothesis

Neil Shearer has been awarded a competitive, internal IFR Scholarship to enable him to pursue a project on "Small molecule signalling in *Campylobacter jejuni*". He will be investigating signalling pathways governing stress resistance in the food-borne pathogen *C. jejuni*, which is currently the leading bacterial cause of human gastroenteritis in the UK.

When colonising the gut, *C. jejuni* must overcome several antimicrobial barriers.

Understanding the signalling pathways that allow the pathogen to detect and protect itself against such barriers is essential for the development of new prevention and intervention strategies to reduce human and avian infection.

Neil joined IFR 18 months ago, having worked at the University of East Anglia and the John Innes Centre and his scholarship is an example of hypothesis-driven research at IFR.



## Shape matters too

The development of tuneable thin film assemblies that contain (bio) nanoparticles is an emerging field in nanobiosciences / nanotechnology.

Functional molecules such as proteins, nucleic acids, metallic and semiconducting nanoparticles, redox-active moieties and virus particles can be incorporated into the ultrathin films, with great potential for applications ranging from biomedicine to electronics.

Researchers at the John Innes Centre led by David Evans focus on the utilisation of viral nano-particles (VNPs) as tools and building blocks for materials science. Their interest in array architecture led them to a collaboration with IFR's Tim Noel and Roger Parker to address the question of whether the shape of the VNPs influences the overall structures of the arrays.

The team found that sphere-like particles showed rapid adsorption kinetics and were retained within the arrays, whereas in stark contrast rod-like particles showed slow adsorption kinetics and were excluded from the arrays, and floated atop the array architecture in an ordered arrangement.

**Publication:** Nicole Steinmetz *et al.* (2008) Layer-by-layer assembly of viral nanoparticles and polyelectrolytes: the film architecture is different for spheres versus rods. *ChemBioChem* **9** 1662-1670

**Funding:** BBSRC, BBSRC Core Strategic Grant and EU grant MEST-CF-2004-504273

## Out and about



Roger Fenwick with Shanthi Wilson Wijeratnam from the Industrial Technology Institute, Sri Lanka

## International esteem

Roger Fenwick has been elected as a Fellow of The International Academy of Food Science and Technology (IAFoST); the presentation will take place at the IAFoST World Congress in Shanghai. He joins Mike Gasson and Vic Morris who were elected in 2006 (in 2006 there were 130 Fellows world-wide, of whom 13 were UK citizens). This election is further reflection of the

esteem in which Roger is held world-wide by food scientists and technologists.

Following a distinguished career in science and in international coordination, Roger retired this year, but continues to advise the Institute on a part-time basis and, in particular, supports ETP Food for Life activities.

## ETP Food for Life Implementation Plan

- Improving health, well-being and longevity
- Building consumer confidence
- Supporting sustainable and ethical production

These are the three key thrusts identified in the draft Implementation Plan for the ETP Food for Life which identifies research, training and knowledge transfer requirements, identifies where there is a need to build new capacities in Europe and identifies, for the first time, the level of resource needed to deliver the programme. There are 31 national food platforms across Europe, Russia, Ukraine and Israel; these will have a vital role in enhancing information flows, identifying regional challenges and opportunities, and ensuring that all parts of the continent can benefit from ETP outputs.

Because small companies make up 96% of the food chain sector, facilitating knowledge transfer and extending the innovation culture is vital. International links are also important so that best practices developed in other parts of the world can be captured, adapted and exploited across Europe.

The IP will be finalised and published in September. Information about the IP, and other aspects of the ETP are available at [www.etp.ciaa.eu](http://www.etp.ciaa.eu)



## Enzymes in the 'championship'

In May 2008, Norwich City Football Club provided the venue, and IFR hosted and organised esEGP5, which provided a comprehensive overview of enzymes in grain based foods and beverages, from fundamental research topics to industrial applications. Experts from the international scientific community presented their latest research achievements and progress, inspiring scientists in this field.

Weblink to presentations: <http://www.ifr.ac.uk/esegp5/default.html>

## Travels with *Salmonella*

This year Jay Hinton has been an invited speaker at the Gordon Conference on 'New Antibacterial Discovery & Development' in Italy, and an invited plenary speaker at the Australian Society of Microbiology Conference, in Melbourne, Australia. His summer travels finish with a more 'local' event, as an invited speaker on 'Systems-level analysis of *Salmonella* infection biology' at the 4th International *E. coli* Alliance Conference in September at the Sanger Institute, Cambridge.

## Peanuts in Ghana

Social scientist Annabelle Boulay has visited Ghana to gather information on peanut production, processing methods, consumption and allergy. The peanut is a staple of the Ghanaian diet and yet the prevalence of peanut allergy is much lower in Ghana compared to countries such as the USA or the UK. She worked in collaboration with the Noguchi Institute and collected data from peanut farmers, processors and consumers in urban Ghana (Accra, south) and rural Ghana (Tamale, north). Her observations will contribute to current research activities in the EU-funded Europrevall allergy project, coordinated by IFR.



Ghanaian farmer, Diare

And on campus

## Visiting IFR

### Food science solutions – fast!

Interest in our new industry service subsidiary has been very strong, and we have had to move fast to find additional staff to carry out client projects. The IFRExtra team are particularly pleased to have recruited Company Microbiologist, KIRRILLY WILSON, a graduate biologist/microbiologist whose previous employer was Kraft Foods in Port Melbourne, Australia.



Kirrilly Wilson

Here she shared in management of the microbiology laboratories, in addition to providing technical support to both the manufacturing facility & product developers. KIRRILLY has HACCP (application & development) & food safety training experience in addition to her specialised investigational work and trouble shooting.

[www.ifrextra.co.uk](http://www.ifrextra.co.uk)



Julia Maldonado-Valderrama, from the Department of Applied Physics, University of Granada, Spain is working as a postdoctoral researcher at IFR for 2 years with Vic Morris and Peter Wilde. Julia is funded by a Marie Curie Intra-European Fellowships in the Life Sciences, to determine how the interfacial composition of food emulsions under physiological conditions can influence lipid digestion (lipolysis) at a fundamental level.

## A starting point for adventures

IFR and John Innes Centre scientists, and Operations Centre support staff, have contributed to a BBSRC-funded outreach project on 'science, art and writing' run by the SAW Trust. The idea is to explore a scientific theme, and find high quality images that illustrate the science as a starting point for adventures.

A junior school project on plant-derived natural products resulted in this poem.....

### Spreading colours

Colourful flames, the light looks alive,  
spreading slowly across the paper.  
Multi-coloured molecules,  
chemicals mixing together,  
sparkling in the light,  
dancing in the alcohol.

**Olivia Heseltine**, age 7  
*Martham Primary School*

The Chief Executive of Norfolk County Council described the celebration 'showcase' event recently held at the BioScience Institutes as "Truly inspirational".

[www.sawtrust.org](http://www.sawtrust.org)



### Our Mission is

- ▢ To undertake international quality scientific research relevant to food and human health
- ▢ To work in partnership with others to provide underpinning science for consumers, policy makers, the food industry and academia

### Updating our Contacts

- ▢ Please let us know if your address is incorrect, or if you would like to receive Science+Innovation by e-mail in future (contact details right)

### Data Protection

- ▢ Copyright & Data Protection [www.ifrac.ac.uk/copyright.html](http://www.ifrac.ac.uk/copyright.html)

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