Microbiologist

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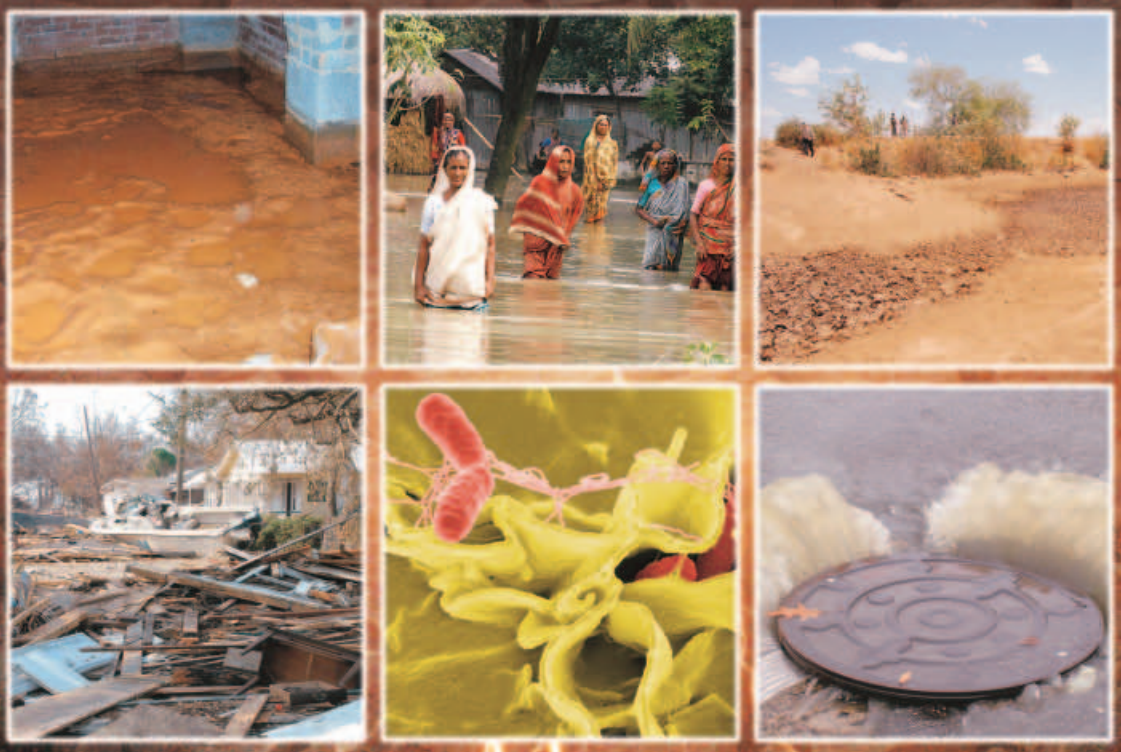

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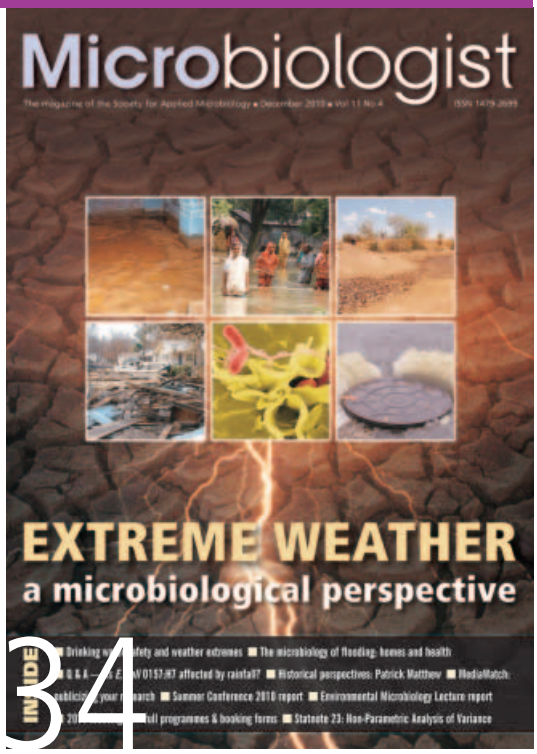
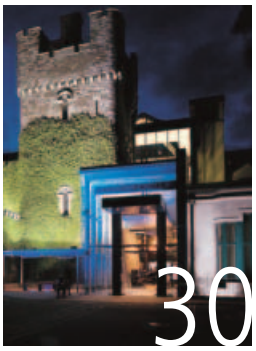
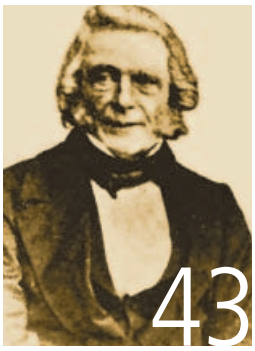
contents





Summer Conference 2011 Full Programme



Historical Perspectives: Patrick Matthew

information

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editorial

Lucy Harper talks about science funding and extreme weather

Science funding has been uppermost in the thoughts of our UK members with the recent Comprehensive Spending Review (CSR). I'm sure you all know that the science budget has been frozen (which in real terms means a cut of around 10%) and much of the scientific community is glad about this outcome. This is thanks in no small part to the Science is Vital campaign, something which has been acknowledged by Minister of State for Universities and Science, David Willetts. According to a tweet from a recent Parliamentary Office of Science and Technology event at which Willetts was speaking: "*Willetts asked about the role of #scienceisvital in CSR, he acknowledges it played an important role.*"[1]

I'm pleased to say that SfAM support this campaign and it's great to see that we've contributed to something which seems to have made a difference.

Most scientists I've spoken to about the outcome of the CSR are tentatively happy with the results. However, Chief Executive of the Society of Biology remains concerned about funding for University Teaching, saying: "*Teaching of university science must be protected with adequate levels of funding... Biology is at the heart of health, the environment, food security, biodiversity and climate change. There is no cheap option for teaching it well. Hands on practical work in the laboratory or field must continue... The additional cost of this must be recognized.*"[2]

One way to influence science funding outcomes is to raise the profile of science, and for us applied microbiology, by publicizing interesting, informative and accurate science. The *mediaWatch* article in this issue (page 18) explores the many facets of publicizing research, looking at both traditional and new media channels.

It seems that science funding has weathered the storm, at least in the short term, and it's the topic of weather which occupies the theme of this issue. On page 34 we hear from Professor Paul Hunter who gives an overview of the effect of extreme weather — both flooding and drought — on water treatment plants. Dr Lorna Fewtrell takes a more personal perspective in her review of the microbiological effects of flooding on our homes (page 37). Finally, the Q&A for this issue asks Mr Pete Money about the role of weather on the spread of *E.coli* O157 (page 41).

Finally, I'd like to ask for opinions about *Microbiologist* and SfAM from you, our readers. What do you enjoy about receiving your quarterly copy of the magazine? Has there been any content which you've particularly enjoyed? Perhaps we've discussed something which is your area of expertise and you'd like to make a comment? Or maybe you'd like to share your thoughts about your SfAM membership benefits? Whatever you'd like to share with the readership, we'd love to publish your letters (or more likely, emails) so contact me and let me know what you think (lucy@sfam.org.uk).

[1]Tweet from Beck Smith of the Biochemical Society
[2]Taken from the Society of Biology website on 29 October 2010: www.societyofbiology.org/home

contribute

We are always looking for enthusiastic writers who wish to contribute articles to the magazine on their chosen microbiological subject.

For further information please email the editor, Lucy Harper at: **lucy@sfam.org.uk**

Lucy Harper

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Advertising: Information about advertising in *Microbiologist* and how to submit advertisements can be found on the Society website.

Website: our website **(www.sfam.org.uk)** is a timely source of up-to-date information on all Society matters and maintains a comprehensive archive of articles and reports on a variety of microbiological topics.

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benefits

The Society for Applied Microbiology is the voice of applied microbiology within the UK and was founded in 1931. Society members play a leading role in shaping the future of applied microbiology, and enjoy many benefits, including:

- The opportunity to apply for one of our many grants or funds.
- Eligibility to win any of our awards or nominate a candidate for the SfAM Communications Award.
- Access to our five peer–reviewed Journals: *Journal of Applied Microbiology, Letters in Applied Microbiology*, *Environmental Microbiology, Environmental Microbiology Reports* and *Microbial Biotechnology.*
- Free access to the entire collection of digitized back files for *JAM* and *LAM* dating back to 1938.
- A topical quarterly magazine, *Microbiologist.*
- Substantially reduced rates for attendance at SfAM meetings and conferences.
- Networking with worldwide professionals in over 80 countries.
- Access to private members area of the SfAM website.
- Monthly email bulletins with the latest news from SfAM.
- Invitation to the annual *Environmental Microbiology* lecture.
- Fostering cross disciplinary research.
- A 25% discount on the extensive Wiley–Blackwell collection of titles.

Detailed information about all these benefits and more can be found on the Society website at: www.sfam.org.uk.

GRANTS & AWARDS: Many grants, awards and prizes are available to members including the W H Pierce Memorial Prize and prizes for student oral presentations and posters at the Summer Conference. In addition to these substantial awards, the Society has funds to assist members in their careers as microbiologists. These include the President's Fund, Conference Studentships, Sponsored Lecture Grants and the popular Students into Work Scheme.

Full details of all the Society's grants and awards can be found on the website together with PDF downloadable application forms.

JOURNALS: The Society publishes two monthly journals: *Journal of Applied Microbiology* and *Letters in Applied Microbiology*. We also produce this quarterly colour magazine, *Microbiologist*, which contains features, topical news stories and full details of our meetings. The Society is also a partner with Wiley–Blackwell in the monthly journals: *Environmental Microbiology, Environmental Microbiology Reports* and *Microbial Biotechnology.*

All Full and Student Members receive free access to the online versions of the Society's journals, and can also submit papers to our journals via an online submission service.

MEETINGS: We hold three annual meetings; the Winter Meeting is a one-day meeting with parallel sessions on topical subjects. The Spring Meeting is a one–day meeting tailored for personnel in clinical microbiology. The Summer Conference is held every July and comprises a main symposium, a poster session, the AGM and a lively social programme. All members are invited to our prestigious annual lecture held to commemorate the success of our *Environmental Microbiology* journal. We also hold joint ventures with other organizations on topics of mutual interest.

WEBSITE: The website is the best source of detailed information on the Society and its many activities. It has fully interactive membership areas where you can find archive issues of *Microbiologist*, exclusive SfAM documentation and much more.

membership options

■ **Full Ordinary Membership** gives access to our many grants and awards, online access to the *Journal of Applied Microbiology*, *Letters in Applied Microbiology*, *Environmental Microbiology, Environmental Microbiology Reports* and *Microbial Biotechnology*, copies of *Microbiologist*, preferential registration rates at Society meetings and access to the members areas of the website.

■ **Full Student Membership** confers the same benefits as Full Membership at a specially reduced rate for full time students not in receipt of a taxable salary.

■ **Associate Membership** is only open to those with an interest in applied microbiology without it being a prime aspect of their job. For example, school teachers and those taking a career break; on maternity leave, or working temporarily in other areas. It does not provide access to any journals or Society grants and awards.

■ **Honorary Membership** of the Society is by election only and this honour is conferred on persons of distinction in the field of applied microbiology. Honorary Members have access to our online journals.

■ **Retirement Membership** is available to Full Members once they have retired from their employment. Retired Members are entitled to all the benefits of Full Membership except grants and access to the Society's journals.

■ **Corporate Membership** is open to all companies with an interest in microbiology. Corporate Members benefits include:

- Quarter page advertisement in each issue of *Microbiologist* (which can be upgraded to a larger size at discounted rates).
- The opportunity to publish press releases, company news, etc., in each issue of *Microbiologist.*
- FREE banner advert on the Society website with a direct link to your company site.
- Up to three members of company staff attending Society meetings at members' rate (this means a 50% discount on non member registration rate).

JOIN US!

You can apply for membership on, or offline. To apply offline, please contact the Membership & Finance Co-ordinator, Julie Wright on **+44 (0)1234 326846**, or email **julie@sfam.org.uk.** Alternatively, write to her at:

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www.sfam.org.uk

microbreak

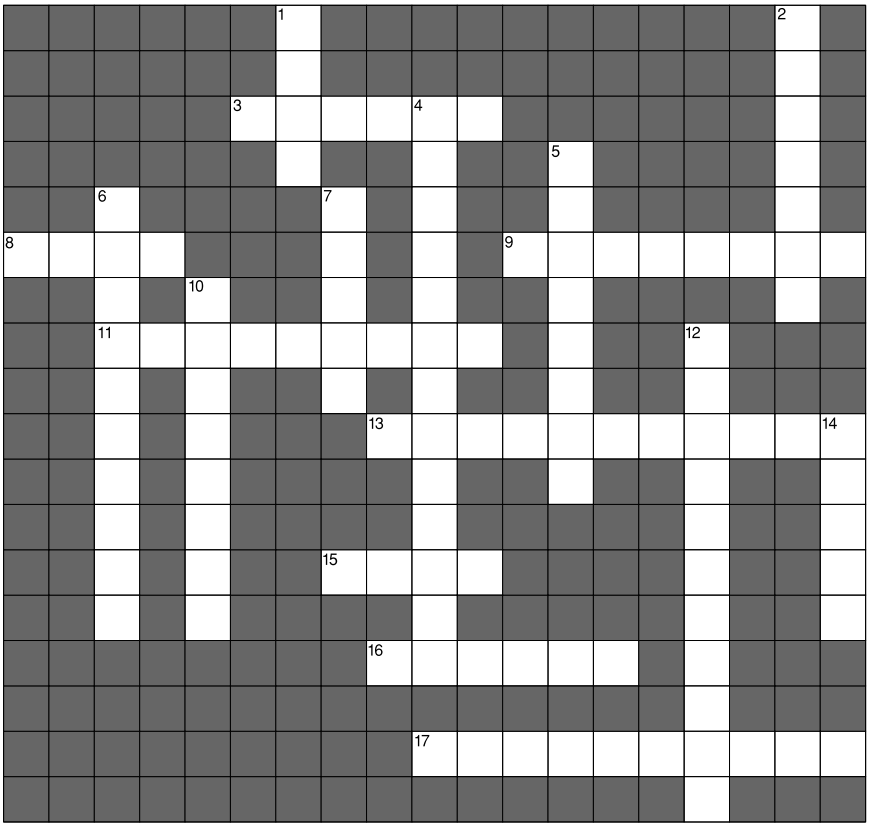
The competition for this issue is a microbiological crossword. Photocopy or scan the page and send your answers to the Editor by Friday 14 January 2011 and you could win an **Amazon voucher!**

Across

3. Father pesters son to disguise virus (6).
8. Messy den hides seagull species (4).
9. Yorkshire river backs on to lean organism (8).
11. Pick–your–own colouring in pigment (9).
13. Whisky–loving bug (11).
15. Developer of weighty stain (4).
16. *Cryptosporidium* has five in average expression of hesitation (6).
17. Small biological thank you for normal flora (10).

Down

1. Companies like Exciting Diagnostics initially made differential agar (4).
2. Bad song to find in films (7).
4. Grandmother's cyst loses a hundred from inner peak (9, 4).
5. Dazzling preposition for Summer Conference setting (8).
6. *Candida* found in sub-tropical islands (10).
7. East in question names CEO (5).
10. Returning everything after apple may lead to Q fever (8).
12. Mixing paint clone produces anti-staphylococcal drug (11).
14. *Salmonella* made of silver, oxygen and sodium (5).



Crossword compiled by Louise Hill-King

The closing date for entries is **Friday 14 January 2011**. The answers will appear in the March 2011 issue of *Microbiologist*.

Name: _____

Address: _____

_____

Simply photocopy this page and send it to: 'Microbreak Crossword', Society for Applied Microbiology, Bedford Heights, Brickhill Drive, Bedford MK41 7PH, UK.

president's column

Geoff Hanlon reviews the latest improvements to the Society's Grants system

You may be aware that the Society's Executive Committee has been examining the structure and focus of our grants system in order to make it more relevant to all our members. At the same time we have been keen to establish a more significant outreach capability for the purpose of benefitting those working in less developed regions of the world. To this end I have devoted a couple of my previous columns to explaining the rationale behind this International Capacity Building (ICB) initiative. These two activities are, of course, linked in that any ICB activity would have to be funded through the grants system.

An extension to the ICB initiative has been the establishment of a new class of Society membership (e–Affiliate) aimed at microbiologists working in the poorest countries of the world. These are referred to as Band 1 countries defined as having a Gross National Income per capita below $1250. Phil Wheat has given details of the e–Affiliate membership in his CEO columns in previous issues of *Microbiologist*. Briefly, the membership is free of charge to those living and working in Band 1 countries who will receive the *Microbiologist* by email each quarter as a pdf file. Online access to our journals is already available to them via a variety of free journal access schemes. These members would not be eligible to apply for our usual grants but a limited number of bursaries will be made available for attendance at the Society's Summer Conference. This form of membership was rolled out earlier this year and to date we have over 70 microbiologists enrolled and I would like to formally welcome them as members of our Society.

For a number of years the Society has had two grants which address some of the issues surrounding ICB. The Overseas Development Award was designed to assist microbiologists in developing countries and Eastern Europe but was rather restrictive and hence was invariably undersubscribed. The Endangered Culture Collection Fund was always fully subscribed but was so highly focused it did not attract applications from the wider membership. The Executive Committee has decided to combine these two grants into a new **International Capacity Building Fund** which will come on stream at the beginning of 2011. The primary purpose of the fund is to provide resources to enhance education and training of applied microbiology in developing countries. Examples of initiatives which may be appropriate for ICB funding might include:

- S*f*AM members to visit overseas laboratories and other facilities in developing countries. During the visit, lectures and other educational activities will be undertaken.
- S*f*AM members resident and working in developing countries to visit appropriate laboratories (perhaps in the UK but not necessarily) to receive training in areas of applied microbiology.
- S*f*AM members to visit sites where it has been clearly identified that an important culture collection is in danger of being lost due to lack of resources. The member will provide training and advice in order to preserve the culture collection either *in situ* or within the country of origin.

This is clearly an opportunity to engage our new e-Affiliate members. There will be a number of existing S*f*AM members in developed countries who would like to be involved in this type of work and yet have no contacts in developing countries. Similarly, our new e–Affiliate members will be acutely aware of their own needs but not necessarily how to address them. One of the Society's pivotal roles may therefore be to bring these two sets of parties together. In light-hearted terms this has been referred to in Subcommittee meetings as establishing a "dating agency". The first stage in this process may therefore be to draw up a list of those members who might be able and willing to provide such education and training (either in their own laboratories or abroad) together with a list of e–Affiliate or other members who feel they might benefit from such training. If we can put members in contact with each other it will then be up to them to formulate an application for funding.

For information I have given below the Terms and Conditions of the new ICB fund.

General Terms & Conditions

1. Applicants must have been a Full Ordinary Member of the Society for at least three years or have their application sponsored by such a member. e–Affiliate members are particularly encouraged to apply via this route.
2. Applicants can only apply once in a 24 month period.
3. Any application to visit a facility or laboratory must be accompanied by a letter of support from that institution.
4. Under normal circumstances a maximum of £5000 will be available for an individual award.
5. Expenses will strictly be paid only on production of relevant receipts.
6. Applications will be considered on an

annual basis and should in the first instance be addressed to the Chief Executive Officer at the Society Office.

- A condition of funding is that a report must be produced for possible future publication in *Microbiologist*.

I would encourage all members (both Full and e–Affiliate) to take advantage of this opportunity and to make this initiative a success. If you are interested in being involved please send your details either to me (g.w.hanlon@brighton.ac.uk) or the office and we will attempt to collate the information. Alternatively, if you already have connections in relevant institutions overseas please consider putting in an application.

A recurring theme in my columns and in those of my predecessors has been lack of take-up of grants. We have plenty of grant money to allocate — please help us to give it away!

Professor Geoff Hanlon
President of the Society

ceo's column

Philip Wheat reports on the latest developments within the Society

As we approach the end of another year it is again time to reflect on the health of the Society. One measure of the general health of S*f*AM is the total number of members and whether this is showing an overall increase or decrease. In these days of economic gloom and austerity, one might expect the number of members to be falling. However, the truth is completely different. I am pleased to report that at the end of 2010, membership numbers have increased by approximately 8% when compared to the same time in 2009. More telling is that when the numbers are compared over a longer period (from the end of 2005), the total membership has increased by at least 32%.

There are many reasons for this increase but fundamentally membership of the Society for Applied Microbiology does offer terrific **value for money** and you can find full details of our membership benefits on page 6. I can confirm that membership subscription rates will not be increased for 2011 and I'm sure current members find it easy to promote the merits of membership to colleagues who have not yet joined the Society. In particular, students should be strongly advised to join, as there is even more value for money for Student Members. Joining the Society and renewing membership is easy and can be done online (using a credit card) by visiting www.sfam.org.uk. I do expect membership numbers to increase once again in 2011. As well as the current membership benefits, we are working on several new initiatives which will enhance the value for money on offer and we hope these will contribute to bolstering membership numbers even further.

In this issue you will find details of the three conferences we will be holding during 2011. I must once again strongly advise that if you are thinking of attending the Summer Conference in 2011 to book as early as possible. We are taking all of the bedrooms at the Clontarf Castle Hotel, Dublin. Allocation of this limited number of rooms will be on a first–come first–served basis. Once these rooms are allocated, further accommodation may be available, but this will not be as convenient. I would also encourage any students reading this to submit an abstract and apply for a **Conference Studentship** to attend the conference*. Also, if you are a Full Member and you would like to attend the meeting but you do not have funding to do so, why not consider applying for a **President's Fund Award** which could give you up to £1000 towards the cost of attending?* (see page 50)

During the last quarter of the year we have conducted an online survey of membership concerning grants and awards. I would like to thank all the members who completed and returned the survey — we received a very good response. We do find the information we gather from these surveys extremely useful and it does help to shape the strategy and direction of Society activities. It also encourages two way communication between those charged with running the Society and its members — something which is so vital for a progressive and vibrant society.

I hope you, as members of S*f*AM, enjoy and take full advantage of the benefits we offer now and into the future. Now all that remains is for me to wish you all a happy festive period and a prosperous new year.

*Preference in the award of the Conference Studentship or President's Fund is given to people who have submitted an abstract.

Philip Wheat
Chief Executive Officer

W H Pierce Prize 2010

At this year's Summer Conference, we were delighted to welcome a presentation by the winner of the W H Pierce Prize. This prestigious prize is awarded each year to a young microbiologist (under 40 years) who has made a substantial contribution to the science of microbiology. The award was instituted in 1984 by the directors of Oxoid to commemorate the life and works of the late W H (Bill) Pierce, former chief bacteriologist of Oxo Ltd and a long-time member of the Society. This year's winner was **Dr Mark Webber** (University of Birmingham, UK)

Mark Webber receiving the W H Pierce Prize from Professor Geoff Hanlon

membership matters

My interest in bacterial genetics first arose during my undergraduate degree in Microbiology at Birmingham (1997) which I followed with a Master's degree in Medical Microbiology and Infectious Diseases, also from Birmingham. During my Masters I was exposed to the problem of antibiotic resistance for the first time and my Masters research project led to a PhD supervised by Professor Laura Piddock.

My PhD focused on the mechanisms of quinolone resistance in a panel of highly resistant clinical isolates of *Escherichia coli* and specifically investigated the role of multidrug efflux pumps in this resistance (Webber & Piddock, 2003). After my PhD I continued investigating the role of efflux in multidrug resistance (MDR) initially in *Staphylococcus aureus*. Later, as part of a collaborative project between Laura's group at Birmingham and Professor Tom Humphrey and Professor Martin Woodward's groups at Bristol and the Veterinary Laboratories Agency respectively, I began to investigate the potential for biocide exposure to select MDR in *Salmonella enterica*. This collaboration proved very fruitful and we were able to demonstrate the ability for various biocides to select for antibiotic cross resistance and evaluate the fitness of MDR mutants in a variety of models of infection to evaluate whether the phenotypes seen were likely to persist in the real world. Currently I hold a BBSRC David Phillips fellowship and now run my own group (still at Birmingham) using a variety of 'omic' technologies to investigate the genetic basis for MDR in *Salmonella* and how *Salmonella* respond to biocide stress in terms of both transcriptome and proteome. I have acted as an editor for the *Journal of Antimicrobial Chemotherapy* since 2003 and the *Journal of Medical Microbiology* since 2009.

Biocides comprise a diverse group of compounds used to prevent bacterial contamination in an enormous number of settings. Biocides are crucial to the prevention of infection and maintenance of hygiene in animals and humans with numerous compounds being used on farms, in food processing plants, in hospitals and increasingly in the home. Bacterial resistance to 'in–use' concentrations of biocides is rare and biocides are often mixtures of active compounds with multiple bacterial targets and can be used at concentrations generally much higher than antibiotics as toxicity is less of an issue. Whilst biocide resistance is rare there are

increasing reports in the literature of bacteria with decreased susceptibility to many biocides. This is a concern as biocide use is the mainstay of infection control and prevention and any failure of biocide treatment regimes can lead to increased incidence of infections. Prevention of infection is currently more important than ever as increasing numbers of bacterial pathogens are becoming resistant to therapeutic antibiotics and the prospect of strains untreatable with current drugs is very real for some species.

Recently the number of products marketed for domestic use which include biocides and are sold as antimicrobial has increased greatly and it is now possible to purchase a bewildering array of antimicrobial products including chopsticks, pens, mugs, mattresses, radiators and even iPhone covers. This has prompted concern about the effects of repeated exposure of bacteria to the relatively low levels of various biocides incorporated in these products and the accumulation of biocides in the environment; triclosan — a commonly used biocide in domestic products — can be readily found in groundwater around the world. Exposure of bacteria to sub–lethal concentrations of biocides has been suggested to be a possible driving force for antibiotic resistance due to selection of mutants with mechanisms of resistance common to biocides and antibiotics, for example efflux.

Our work has focused on biocides used in farming and in the home and evaluated the consequences of exposure of *Salmonella* to various biocides to evaluate whether this potential problem is real. We have demonstrated that repeated exposure of *Salmonella* to various biocides does select for MDR mutants and that efflux pumps (particularly the AcrAB-TolC system) are de-repressed in these mutants and contribute to the MDR phenotype (Randall *et al.*, 2007; Karatzas *et al.*, 2007; Webber *et al.*, 2008a; Webber *et al.*, 2008b). One interesting observation has been the different potential for biocides to select for MDR mutants suggesting that development of new biocide formulations could alter the propensity for antibiotic resistance to arise. The use of technologies which have become available in the last decade has allowed us to begin to define the genetic and transcriptomic basis for the MDR we have seen after biocide exposure. These experiments have revealed that the MDR phenotype observed is underpinned by large scale changes to the *Salmonella* transcriptome including alterations of various metabolic pathways. One example of how biocides can select for mutants with altered metabolic pathways has been seen with mutants selected after exposure to triclosan (Karatzas *et al.*, 2008; Bailey *et al.*, 2009). These mutants whilst carrying known mutations in the specific target of triclosan, FabI, also showed alterations of a variety of metabolic genes involved in the biosynthesis of fatty acids (the pathway inhibited by triclosan) identifying a secondary mechanism of resistance to triclosan. Similar results have been seen with other biocides and our current focus is investigating the genetic basis by which global changes in gene expression result from biocide exposure and determining which genes are key to biocide and antibiotic resistance in *Salmonella*.

I would like to thank all colleagues and collaborators past and present who have been involved in this work and of course S*f*AM and Oxoid for the great honour of being awarded the 2010 W H Pierce Prize.

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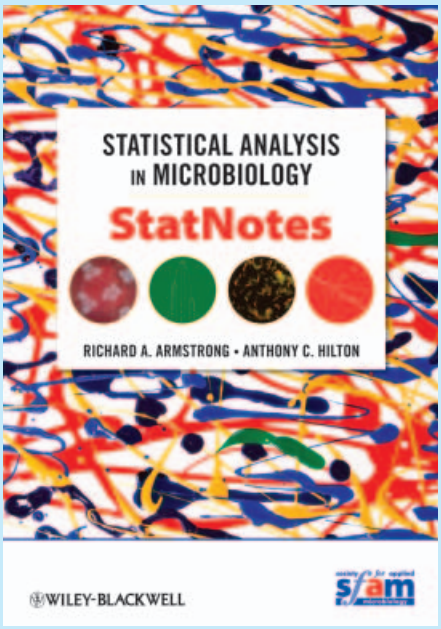
Mark Webber
University of Birmingham, UK

Statistical Analysis in Microbiology: StatNotes

By Richard A Armstrong and Anthony C Hilton. Published by Wiley–Blackwell / SfAM, 2010



Statistical Analysis in Microbiology: StatNotes has been designed specifically for microbiologists who are involved in experimental research and need to draw accurate conclusions from their findings. It features 28 StatNotes that together enable you to understand the basic principles of statistics, choose the correct statistical methods to analyze your experimental data, and work with a variety of commercially available statistical software packages. These StatNotes are based on a series of popular articles published in *Microbiologist* and explore a variety of topics in statistics that are essential for analyzing experimental data, including:

- Nature of variables.
- Comparison of means of two or more groups.
- Non–parametric statistics.
- Analysis of variance.
- Correlation of variables.
- Multiple linear regression and factor analysis.

Throughout the book, the logic and mechanics of each statistical test presented are carefully explained. Moreover, each statistical test is illustrated with examples drawn from actual experiments and research data in microbiology. As a result, you can clearly see how each test is interpreted and what types of conclusions can be drawn from the research data.

In the back of the book, you'll find a glossary of statistical terms and their abbreviations as well as a summary of sample size calculations. You'll also find two appendices that help you select the most appropriate statistical tests based on the type of research you're conducting and the type of data that you're gathering.

Given the wide variety of statistical software packages, it's essential that you understand the underlying principles and purpose of each statistical method; applying an inappropriate statistical test can easily lead to the wrong conclusions.

Written specifically for microbiologists, the highly acclaimed and popular StatNotes enable you to choose which statistical methods should be applied to analyze and draw correct conclusions from your experimental data.

Public Engagement and Innovative Project Grant report

Pupils and teacher from Clepington Primary School

The S*f*AM Public Engagement and Innovative Project Grant can be used to develop an innovative piece of work associated with applied microbiology which has public engagement as its main focus. Here, **Dr Katie Blackett** explains how she used this grant to engage with primary school children about microbiology and the role of bacteria in health and disease

Germ Wars was a collaborative microbiology project developed and delivered by Dundee Science Centre (DSC) in partnership with the University of Dundee and Dundee City Council. This science and literacy project, which was piloted between April and June 2010 enabled 80 local Primary 6 pupils to become engaged with microbiology, and the roles of both beneficial and harmful bacteria in health and disease.

The Germ Wars venture was based on an already established project '*Crazy Creatures*', which explores the topic of biodiversity, utilizing the '*Crazy Creatures*' book by Edinburgh based author, Gill Arbuthnott. *Crazy Creatures* has been running with Dundee Schools for three years, providing pupils with their own copy of the book and a hands–on science workshop, followed by a visit to the centre to meet the author. This project is extremely popular, receiving high acclaim from Her Majesty's Inspectorate for Education, being the subject of one of their case studies. While researching other works by Gill Arbuthnott, I found '*Germ Wars*', which makes the subject of microbes fun. The book describes a range of nasty diseases, the history of vaccines and antibiotics, and what the future holds for our relationship with microorganisms. These multidisciplinary projects support the new Curriculum for Excellence, providing a cross–curricular activity, linking 'real' science and literacy.

This project began with a Continuing Professional Development (CPD) training session for teachers, introducing them to the workshop and the overall three month project. Following this, in April, Moira Foster, an expert children's librarian from the council Educational Development Service delivered the books to the excited pupils. In May, we hosted '*Magnificent Microbes*', a Meet–the–Scientist event organized by Dr Nicola Stanley–Wall, where visitors to the centre met microbiologists from the University of Dundee. We invited the schools to come and meet the researchers and engage with their research. Displays and hands–on activities explained basic microbiology, biofilm composition, soil and food microbiology, renewable energies and much more. The pupils had an amazing time and were still buzzing about it two weeks later!

In June I visited each school to deliver the workshop '*Befriending Bacteria*' — it was important to give the pupils an all–encompassing view of microbiology. I began with an introduction to microbes, with pupils remembering bacteria and viruses, and with a bit of prompting, they even remembered yeasts. The pupils shared some of the facts they had learned from the book, such as humans hosting more bacterial cells than those of their own body. They were surprised to learn that there are around five nonillion bacteria here on earth.

Biofilms were described as a big community, just like a city. The pupils were shown pictures of a selection of jobs in their community, including waste disposal, the army and doctors. For each picture they were asked to think about what bacteria do in their community that relates to this job. The pupils loved this activity, and there was a lot of discussion and questions about all the things bacteria might do for us. Yucky pictures of biofilms growing on a tongue and toothbrush bristle resulted in some big gasps at the end.

An activity previously carried out by Dr Derren Ready, University College London, was adapted for use in the workshop. To demonstrate how a biofilm is built and the effects we can have on bacterial growth due to the foods we eat, we asked the pupils to create a simple dental plaque out of themselves. They loved this, especially pretending to 'attack' the tooth with acid when they'd eaten too much chocolate and sweets.

Dr Nicola Stanley-Wall with pupils at Magnificent Microbes event

We then did a group activity to build presentation skills. Each group was allocated a nasty disease from the book (Black Death, Spanish Flu, Smallpox, Anthrax and Malaria), and were then challenged to design a drama or presentation to demonstrate why their disease was the most deadly. The pupils really engaged with this and I stayed longer to give them more time. Some fantastic dramas, posters and even raps were created. I finished with a quick fire round of questions, recapping what the pupils had learnt throughout the project.

At the end of term, pupils visited DSC to meet Gill Arbuthnott, where she discussed her book and stressed microbes' importance on Earth and for our survival. The pupils were enthralled and excited to meet the actual author of the book they had been so involved with for 10 weeks.

One of DSC's main objectives is to create an environment for lifelong learning, hoping to inspire confident learners who will go on from the experience enthusiastic to find out more. To help contribute to this mission, DSC provides loan boxes for the classroom. These are a free resource full of equipment and activity ideas to help teachers follow on from what the pupils have learnt in our workshops.

Funding from this grant enabled us to create a Microbiology loan box, full of resources to allow primary children to get more familiar with hands–on microbiology. Resources include: 20 '*Germ Wars*' books, a microscope with associated equipment, a UV light box and a range of Glo products for epidemiology sessions. Additionally, a resource pack is provided for the teacher, instructing them how to use the equipment and detailing a range of fun activities.

This project was so enjoyable to take part in, being able to communicate my excitement about microbiology, while also engaging pupils with books and reading, which will hopefully carry on throughout their summer holidays and possibly their lives. This project exceeded the expectations of ourselves and our partners. The teachers really enjoyed running this project with their class, learning a lot about this subject, hopefully giving them the confidence to do their own microbiology projects in future. Due to its success, we are currently seeking funding to allow *Germ Wars* to be rolled out to up to 10 schools next year. Many thanks to *Sf*AM for sponsoring this multidisciplinary venture, enabling us to get primary schools involved in an extensive microbiology project, and also create a resource for continual learning.

Dr Katie Blackett
Dundee Science Centre

Membership changes

NEW MEMBERS

We would like to warmly welcome the following new members and hope that you will participate fully in the activities of the Society.

Australia

C. M. Chambers; C. Day; D. Fahmy; E. Khosa; S. Ma'ayeh; A. L. Nguyen; A. Obeng; A. Pavic; K. Schliephake

Austria

B. Klug

Bangladesh

M. Kawsar; Md. A. Salam

Botswana

V. Khumalo

Cameroon

A. R. Boja Ppepsicolman Bebeng; P. C. Chi; K. Meferi; D. Oumar

China

Y. Huang

Cote d'Ivoire

H. Atta Diallo

Czech Republic

K. Demnerova; R. Karpiskova; J. Pazlarova; S. Purkrtova

Denmark

F. Akabanda; J. Leisner; J. Owusu-Kwarteng

Ethiopia

A. Bayeta; S. Gabre; T. Genene; M. Getachew; E. B. Hizikias; T. N. Iticha; M. Seman

Ghana

F. Adzitey; B. Campion; R. L. K. Glover; S. Kolekang; E. N. Kpikpi

Grenada

R. Kabuusu

Greece

M. Papadelli; G. Tsiamis

India

M. Painuli; V. S. Reddy

Ireland

C. Byrne; A. Piterina; T. Ringwood; S. O. Apiyo

Kenya

E. M. Njeru; M. O. Oyaro

Malaysia

T. Hadibarata

Nepal

S. D. Joshi; R. Mallik; J. P. Mathuria; P. Rai; S. Thapa

Nigeria

A. O. Adelekan; E. B. Agbo; O. Aiyegoro; B. J. Akinyele; P. Akpa; O. Alabi; A. O. Atayese; H. N. Ayo-Omogie; S. S. Baba; F. Doherty; C. N. Ezekiel; L. B. Fakayode; O. A. Feyijen; D. Haruna; Y. A. Jeff-Agboola; U. C. Kanife; J. O. Kayode; O. T. Kayode; E. Mbah; B. Musa; C. Nnamchi; L. Ofodile; P. O. Ogunlade; A. O. Ogunleye; I. O. A. Oguntoye; M. Oke; G. N. Okpala; M. Opara; E. Otunola; O. Salami; A. Sanyaolu; Y. M. Somorin

South Africa

P. Gouws; C. Witthuhn

Sudan

B. E. Elamin; A. Elshayeb; K. Musab; M. Safieldin; A. Yousif

U.K

E. Olsson Engvall; C. Adamson; G. Ahrens; J. Banks; A. Brown; M. Bull; D. Burch; M. Burgin; P. Cheetham; L. Chitturi; A. Costabile; H. Fairclough; R. A. Fewings; J. Fowler; H. Gough; J. Griffin; A. Gunn; J. Houghton; P. Johnston; M. Leung; J. G. Magee; L. Mcinroy; A. McKinven; G. Mills; H. Muhamad Ali; B. Ouma; K. Page; N. Pantidos; M. Patel; S. Pitt; M. Pope; S. K. Quli; A. Rakhimova; J. Rawling; D. Rozen; C. Sanders; A. Skepple; J. Stephenson; R. Thwaites; D. Tourigny; G. Walton; J. Wardyn; P. J. Watson; M. Webber; G. Wilson; C. A. Yates; R. Zia

U.S.A

B. Aktas; Y. Alsaadi; M. Ault; A. Ferreira; T. Lusk; N. Parker; A. Parks; K. Wasiluk

Uzbekistan

E. Seydametova

West Indies

V. Amadi

Yemen

A. A. S. Al-Asbahi

Zambia

M. Lewanika; N. Mutale Mutwale; L. Mwale; M. Nsomi

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A. Chemura; L. Mlera; M. A. Osman

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New Committee members

SfAM would like to welcome three new members of Committee. Here they introduce themselves

Irene Grant

I joined the Society for Applied Bacteriology (as it was then) in 1988 whilst studying for a PhD in Food Microbiology at Queen's University Belfast — I have the distinction of being Dr Margaret Patterson's first PhD student.

Several post-doctoral research positions ensued, initially related to the microbiological effects of food irradiation and subsequently to the potentially zoonotic pathogen *Mycobacterium avium* subsp. *paratuberculosis*. Amazingly, various aspects of the latter have been the main focus of my research since 1993. In early 2006 I

became a lecturer in Microbiology and Food Safety within the School of Biological Sciences at Queen's University contributing to BSc Food Quality, Safety and Nutrition and Biological Science degree pathways.

Over the years I have contributed to and benefitted from the Society for Applied Microbiology in various ways — attending a number of Summer Conferences to present my research, being awarded the W H Pierce Prize, publishing papers in Society journals, taking advantage of Students into Work grants and, most recently, the President's Fund. I am looking forward to serving on the Committee and giving something back to the Society.

Katie Laird

After completing my degree in Biology, I gained a PhD in 2008 from the University of Northampton where I studied the antimicrobial effects of citrus essential oil vapours against *Enterococcus* sp. This research led to the development of an antimicrobial vapour which has since been patented. My postdoctoral work included looking at the effects of the vapour against fungi such as *Aspergillus* sp. and *Penicillium* sp. on grain and the effects of clinical waste movements on the transmission of Hospital Associated Infections (HAIs). Currently I work as a senior lecturer in Pharmaceutical Microbiology at De Montfort University; lecturing on both the Pharmacy and Pharmaceutical and Cosmetic Science degree courses and the Pharmaceutical Quality by Design MSc. My research interests include biofilms, survival mechanism of *C. difficile* and novel antimicrobials against HAIs. I have been a member of S*f*AM since 2005 and was one of the founding members of the Postgraduate and Early Career Scientist (PECS) committee, I am pleased to have this opportunity and look forward to contributing to the Society as a member of the S*f*AM Committee.

Clare Taylor

I joined the Society in 1997 when I was working on my PhD in Microbiology at the University of Manchester and since then I have developed a deep affection for all things microbiological, and in particular for pathogenic microbes. Following my PhD, and after a very brief spell as a technical specialist with Medeva Pharma Ltd, I returned to the lab in Manchester as a postdoctoral researcher and worked on different projects ranging from biotechnological applications of capsular polysaccharides to capsule and LPS biosynthesis. In 2004 I joined a new lab with Dr Jen Cavet which is where I fostered my interest in intracellular pathogens. I was appointed as a lecturer in Medical Microbiology at Edinburgh Napier University in 2007 and since then I have been developing my research as an independent investigator. The main focus of my research is understanding host-microbe interactions, particularly of intracellular bacteria that cause human infection and the aims of my research are to understand how bacterial gene expression is modulated in response to the host environment and how this contributes to microbial pathogenicity and survival.

I am also involved in several multi-disciplinary projects and the applied aspects of my research include developing novel antimicrobial strategies, involving collaboration with colleagues in chemistry and endocrinology as well as with industry.

Outside of my research I have a keen interest in encouraging people into science and I am a STEM Ambassador which allows opportunities to engage with young people in particular. I am delighted to serve on the Committee and look forward to contributing to the continued growth and success of a Society that has supported me in numerous ways throughout my career.

British science festival

In September S*f*AM were involved with three events at the **British Science Festival**, an annual event run by the British Science Association held at different locations around Britain and Ireland each year. This year, the venue was Aston University, Birmingham. The festival ran from Tuesday 14 to Sunday 19 September at venues across Birmingham

The first of the events supported by S*f*AM took place on Wednesday evening. **Grime scene investigates: at home with the microbes** was run by Dr Anthony Hilton, of Aston University. He gave a fascinating talk about his experiences working on the BBC TV show *Grime Scene Investigation*. Anthony began by explaining that people are increasingly aware of the relationship between them and microbes, from drinking probiotic drinks to using antibacterial hand wash. He then took us on a tour of what he found when he took his mobile laboratory to people's homes. From the curious to the

downright disgusting there were many microbial surprises in store. Anthony interspersed explanations of the microbiology with video clips of some of the scenes.

Anthony was also involved in **The body in health and disease**, an exhibition which ran in the Great Hall on Tuesday, Wednesday and Thursday. Anthony was on hand to talk about microbiology and show visitors just how well or badly they washed their hands. Participants received prizes for washing their hands well — from microbial stickers to sticky bugs.

On Thursday evening a group of scientists and members of the public gathered together with a drink and some light refreshment to discuss infectious disease. The *Sf*AM organized event was called **Outbreak: engaging the public in infectious disease**. All of the audience were armed with pens and postcards to jot down ideas, questions and feedback from the event. The evening began with informal chatter before Professor Jo Verran (Manchester Metropolitan University) facilitated a discussion on people's perceptions of infectious disease. There was a wide variety of answers reflecting the diverse audience, from a priest who felt that during the swine flu outbreak there had not been enough support available and asked where he could go for information should this happen again, to concerns over the use of antibiotics and alcohol hand gels leading to antibiotic resistance. The impact of films on the public understanding was then discussed and this question was asked: how necessary was scientific accuracy?

We then all settled back to watch the film Outbreak having been asked to keep a few questions in mind:

- Were there any scientific inaccuracies in the film?
- If so, did these interfere with our enjoyment and/or understanding of the film?
- Did the film enhance our understanding of infectious disease?
- Did it raise any further questions about infectious disease?
- How did the film make us feel about infectious disease?
- Would the film alter our behaviour if this sort of event did happen?

Following the film Jo continued the discussion. There were several people in the room who had spotted problems

with the science contained in the film: from errors in the portrayal of electron microscopy, to 'scientists' not wearing masks and gloves in a level three containment lab! Equally, the speed with which an antiserum was developed was considered unrealistic by some members of the audience. This then raised the question: does it matter if the science is inaccurate? Many of the audience argued that if the science had been completely accurate it would probably have made for a very long and probably quite boring film.

The discussion continued for quite some time with questions flowing from the audience about microbiology and infectious disease, covering topics including would a fire bomb have killed off the airborne virus and what emerging diseases should we be concerned about. The evening was a great success and everyone seemed to thoroughly enjoy themselves.

Clare Doggett
Communications Officer

The final *Sf*AM sponsored event took place over the weekend in a marquee in the centre of Birmingham and was the **Microbe and organelle activity parlour**.

We were allotted a stand in the marquee in Centenary Square. On the back wall we hung posters with simple diagrams of a bacterial cell and a eukaryotic cell and a poster crediting artistic contributors and sponsors. On the side walls we hung photos of cells taken with microscopes by members of staff at Aston University. The photos were mounted on thin Styrofoam and were accompanied with brief descriptions of the scientists and the cells which were photographed. They combined art with science as they looked like a combination of art hung in a gallery and figures with legends similar to those you would see in a journal article. On the tables we had four stations: a collection of children's books on microbiology and cell biology for browsing, an activity sheet with accompanying stickers of organelles, bespoke biscuits hand decorated with a mitochondrion or the golgi apparatus, and temporary tattoos of bacteria and mitochondria. Unfortunately moving a fancy microscope to the city centre proved to be difficult. The stand was staffed by a mixture of undergrads, postgrads, postdocs, and faculty staff. All wore T-shirts sporting a painting of mitochondria by Orda Noel, once again blending art and science.

Visitors picked out their desired tattoo and/or biscuit. They were then shown on the activity sheet where they could learn more about the microbes and organelles which appeared on them and of course how to remove the tattoos if or when they wished to do so. Whilst the children were choosing what they wanted and during the application of the temporary tattoos there was time for adults to look at the photo gallery and some even looked at the children's books. We didn't count visitors but gave away 200 biscuits (the first to run out), 200 sets of organelle stickers, 200 or so microbial stickers (ideal for kids if parents objected to tattoos), 350 activity sheets, and about 1000 tattoos. Most takers were families, but we also gave stickers, tattoos and activity sheets to teachers to use in their classrooms.

Ann Vernallis
Biology/BMS Programmes, School of Life and Health Sciences, Aston University

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Pseudomonas
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Environmental Microbiology Reports

Symbiosis
Edited by: Paola Bonfante, Karen Visick, and Moriya Ohkuma. *Environmental Microbiology* Reports, **Vol. 2**, no. 4, August 2010

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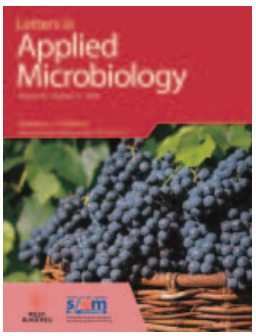
Vibrio Ecology
Edited by: Carla Pruzzo, Balakrish Nair, Jim Oliver and Rita Colwell. *Environmental Microbiology Reports*, **Vol. 2**, no.1, February 2010



Letters in Applied Microbiology

Wine Fermentation — Virtual Special Issue. *Letters in Applied Microbiology*, August 2010
Antimicrobials — Virtual Special Issue. *Letters in Applied Microbiology*, August 2010

Microbial Biotechnology

Marine Omics
Editors: Laura Giuliano, Michele Barbier and Frédéric Briand. *Microbial Biotechnology*, **Vol. 3**, no.5, September 2010
Biocatalysis
Edited by: Karl-Erich Jaeger, Andreas Schmid and Manuel Ferrer. *Microbial Biotechnology*, **Vol. 3**, no.1, January 2010

Journal of Applied Microbiology

in the Press
A recent study by SfAM member Anna Snelling and her team at Bradford University looked at the effect of different methods of hand drying on bacterial load and transfer. The study was funded by Dyson and attracted much media attention including stories in *The Washington Post*, Telegraph.co.uk, Express.co.uk and *New Scientist*.

Lucy Collister
Wiley-Blackwell

mediaWatch

microbiology and the media

If you have any views on science in the media which you think should feature in this column, please send them to the Editor at: **lucy@sfam.org.uk**

Publicizing your research

The issue of scientists publicizing their research is becoming more and more important. Funders expect scientists to spend a certain amount of their time communicating research to lay audiences. And funding is one of the reasons why the communication of science is so important. The logic goes something like this: raising the profile of science in the minds of non-scientists — in particular policy-makers and politicians, means that in these economically trying times, science isn't forgotten as a vital component of any economy

So how can those at the coalface (or benchtop), contribute to raising the profile of science? One way of helping to secure a future for science funding is to ensure that good, credible and interesting science is put out there for all to see. A survey by Pew Research Centre for the People and the Press in 2009 stated that most Americans express at least a passing interest in news about science, with 35% saying they enjoy keeping up with science news "a lot" and another 41% saying they enjoy keeping up with it "some." So the science news, it would seem, is a great place to start. As a Society, S*f*AM encourage our members and non–member scientists to help by responding to media enquiries and publicizing the papers they've published through our journals. We've also created a presence on Facebook and Twitter through which we encourage anyone with an interest in applied microbiology to get involved.

As a precursor to the 2010 S*f*AM Summer Conference, delegates were invited to a workshop on publicizing science through the media. The day was designed to introduce delegates to the different ways in which they can publicize their research, through traditional news media and online tools such as blogs, Facebook and especially Twitter: who to work with and how to avoid the pitfalls.

We had a superb panel who shared their perspectives on all aspects of publicizing scientific research:

- Dr Mark Fielder — Hon. Gen. Sec of S*f*AM and Reader in Medical Microbiology at Kingston University.
- Lucy Collister and Lynne Miller from Wiley–Blackwell.
- Alok Jha — science and environment correspondent from the *Guardian*
- Ed Sykes — Press Officer for the Science Media Centre (SMC).
- Ed Yong — Information Officer for Cancer Research UK and founder of the multi-award-winning science blog "Not Exactly Rocket Science".
- Dr Bernard Dixon OBE (Chair of the first session) — an established science communicator, previous Editor of *New Scientist*, European Editor for the American Society of Microbiology and writer of a regular column for *Lancet Infectious Diseases*.

Mark kicked off by describing his experiences working with the news media. He regaled us with a horror story involving a lobbying organization who misquoted him on a sensitive topic. This had some serious repercussions for Mark. The organization in question did eventually write him

a letter of apology, but the utility of this was questioned — as Mark said: "*I'm the only person who's seen it*".

That didn't stop him from picking himself up, dusting the wrong information off and starting all over again. He has since worked on a number of media enquiries for S*f*AM and Kingston University, working alongside journalists, including panel member Alok Jha, to get reliable science into the news and to prevent the distribution of misinformation.

He had many words of advice for our delegates including:

- Know who you're talking to — ask who they are and who they work for so any hidden agendas become apparent.
- Get media trained.
- Know your limitations — make sure you're the right expert and if you're not, offer an alternative.
- In a hospital/government agency you may be limited — know what you can and can't talk about.
- Know your message — a call from a press office will provide a few minutes to collect your thoughts.
- Repeat your message if necessary.
- Don't get cross — losing your cool means you lose your argument.

It seemed comforting to the delegates to hear Mark's experiences straight from the horse's mouth. Mark has certainly learnt from his bad experience and most importantly not let it stop him from publicizing his science again. During the subsequent discussion session, we heard that a survey by "*Science*" found the majority of scientists reported a positive experience when working with the news media.

Next we heard from Lucy Collister, Marketing Manager for Wiley–Blackwell who explained how S*f*AM and Wiley–Blackwell publicize the science which is published in S*f*AM's journals. This process begins with a paper being highlighted as potentially interesting to the general public. In consultation with the author(s), and their institution(s) a press release is written and distributed. An embargo may be used on press releases: this is a date before which no information about the contents can be publicized. Embargoes are considered controversial by some, but fundamentally they are designed to assist journalists, giving them time to check facts, speak to the author and write a story before the information becomes publicly available and therefore no longer 'news'.

Lynne Miller, Associate Marketing Director of Wiley–Blackwell then explained other ways in which the science published in the Wiley–Blackwell journals is publicized. She explained: "*Article publicity is extending beyond traditional methods of news and includes new social media and blogs. We are looking at the ways in which people prefer to receive content*." Lynne went on to describe the various Twitter feeds run by Wiley–Blackwell. Their Darwin Twitter feed was acknowledged as a suggested science site by Twitter earlier this year and this increased their followers to over 30000, making it an extremely worthwhile method of information dissemination.

During the discussion that followed, we learnt that a study from the *New England Journal of Medicine* (Philips *et al.*, 1991) found that papers which are publicized through the news media tend to be cited more by other scientists. This illustrates that such publicity isn't merely about getting a message across to the lay public, it's also about communicating with peers.

After a delicious lunch I took on the role of Chair for the second session of the day which began with Alok Jha who described his job: "*I'm never writing to impress scientists, or professors .... or editors who'll turn me down, I'm always writing for a reader who will stop reading given half the chance. I imagine them standing at a tube station, reading something, not finding it interesting and moving on. So that means that what I write has to be entertaining and interesting in and of itself*."

This need to keep readers interested explains the language often used by journalists. Writing in a complicated way can be confusing. Using short sentences with simple words to tell stories is most effective — although this is often difficult when writing about science, which is littered with long complicated words.

The *Guardian*, like many news outlets, is using different media platforms including online content and podcasts. These are excellent ways in which to reach wide-ranging audiences and introduce science to people who might not otherwise read and/or listen to such content. However, it does mean there is increasing pressure on journalists to fill these spaces with interesting, informative and accurate content.

Alok emphasized the difference between the timescales normally experienced by journalists, versus those understood by scientists. He normally writes two or three articles every day and often has some compelling politics, business or world news to compete with for space. So deadlines are much more immediate in journalism. Alok described the ways in which scientists can help him and other science journalists. Most importantly, scientists must respond to calls as quickly as possible — preferably within the hour — even if it's to say you can't answer their question(s).

If you can help, you lessen the opportunity for a journalist to misinterpret what you're saying by modulating the language you use. Alok said: "*when you talk to your mother and father and your friends or to scientists, you don't speak in the same language*."

Finally, if you're publicizing a research paper and an embargoed press release has been written and distributed, you should ensure you're available on the day before the paper comes out. That's when a journalist will need to get in touch with you, so to maximize the potential for a news story to be published, you need to be there to help.

The discussion session that followed, raised the issue of simplicity of language and whether this is considered 'dumbing down' science. In response, Ed Yong put forward Darwin's "*On the Origin of Species*" as an example of a simply written work describing extremely complex concepts, saying: "*there's no correlation between sophistication of thought and simplicity of language.*"

Headlines were also discussed and Alok clarified that sub–editors write newspaper headlines. So if any coverage of your science contains a headline you're not happy with, you are encouraged to look past the headline to the content of the article itself.

The next speaker was Ed Sykes, Press Officer for the Science Media Centre (SMC) who spoke about the role of the SMC in connecting the right scientists with national journalists in the UK news media. The SMC was established in 2002 in response to some of the media controversies surrounding scientific subjects such as GM crops and the MMR vaccine. The SMC works hard to maintain a database of journalists and scientists who work together to ensure accuracy in science reporting, through rapid reactions, press briefings, round-ups and myth–busting services. As scientists, you can help by offering your expertise to the SMC's database. If you're new to publicizing your research you can also take advantage of their "Introduction to the news media day" and read the really useful 'top tips' leaflets, which can be downloaded from their website.

Ed finished off with some wise words of advice:

1. If a journalist calls you, find out: who they are, who they're writing for and what their deadline is.
2. Contact your press officer for help and advice.
3. The worst thing that can happen is for you to not communicate. If you don't, you leave a vacuum which someone else (potentially less qualified) will fill.

The final speaker was Ed Yong, who talked about communicating directly with the public through blogging. A report from the Pew Centre compared types of stories represented in traditional media and in blogs. In traditional media, science makes up 1% of the stories and is the 23rd most popular topic. In blogs it makes up 10% and is the 3rd most popular blog topic.

He then quoted Batts *et al.*, (2008) "*scientific discovery occurs in the lab one experiment at a time. Science itself moves forward based on a series of ongoing conversations, from a Nobel Prize winner's acceptance speech, to collegial chats in the park. When these conversations flow into the mainstream they nurture the development of an informed public who understand the value of funding basic research and making evidence based decisions. It is in the interest of scientists and academic institutions alike to bring these conversations into the public sphere.*"

He advocates the two–way interaction provided by blogs which have the power to critique bad science. If you see something that's wrong in a blog, you can correct it and bring it to the public fore providing a valuable public service. Often such critiques go beyond what journalists can do — they give a much more in–depth and opinionated picture of why something is considered bad research. In some ways blogs are a better forum for such critique — there are no space limits and one can talk about how the latest developments are standing on the shoulders of giants who preceded them. They can also focus on neglected areas of science — for example niche fields deservingly getting attention online include blogs entitled "This week in virology" and "Parasite of the day".

By communicating directly through blogs, you can be a great teacher and communicator without ever having to set foot in a classroom or newsroom.

Blogs can also be linked to by individuals or organizations which at first glance don't have a direct interest in science. Ed says: "*we're moving beyond a system where people click on the science pages of a newspaper site or go to a science blog because they want to find out about science. Some of my most popular blog posts have been linked to by all sorts of places.... from sword manufacturers, to those involved in role playing.*"

Ed was asked about the perceived danger of misinformation being passed on, as blogs have no system of peer review. Ed responded: "*This is what comments are for..... I guarantee if I wrote something that was inaccurate or if my arguments were poor, I would have an army of geeks lining up to tell me the many ways in which I was wrong. There's capacity for misinformation in any media, but with blogs there's a culture of transparency and of receiving criticism from people.*"

We concluded the day with a discussion about Twitter and how it has impacted the work and lives of the panel members. A quick poll of the audience revealed that very few have used Twitter and even fewer do so on a regular basis.

After a brief explanation about the mechanics of Twitter (see *Microbiologist* Vol.10, No.3, p14), Ed Yong described it eloquently, thus:

SfAM policy on the media

We will:

- always do our best to provide facts, information and explanation.
- if speculation is required, explain the rationale behind that speculation.
- desist from hyping a story—whether it is the journalist or the scientist doing the hyping.

"Imagine you take all your favourite people and you put them into a room. These aren't necessarily people you know, but you do have to like what they say. Those people then talk to each other, some of them shout random things, some of them mention things they've read elsewhere.... and some are just waving at the back. You then walk into the room from time to time. You listen to what they say, you mingle among them, see what interesting things they can point you towards — sometimes you have a conversation — and then you leave again. What you get out of it depends on how much you give to it — if you walk into a party and don't talk to anyone you're not going to get very much back. If you're very interesting and talk about interesting things you'll get a lot back. It is surprisingly like real life interactions."

He summed up the utility of Twitter by listing the ways in which he uses it, describing it as the single most useful tool he has at his disposal as a science communicator, for:

1. Publicizing his work.
2. Networking and forming links with other like–minded people and those working in the field.
3. Chatting with some of the worlds top journalists, writers, scientists.
4. Crowd–sourcing — i.e. asking his followers for help:
   a. to find out information from experts.
   b. to find sources for articles.
   c. to check facts and ways of describing things.
   d. to kill a virus on his computer.

But most importantly: "*it is my own personal newspaper where all the Editors are the world's best journalists and writers. They are constantly feeding me stuff I want to read, and I know I want to read it because I trust them and their opinions....And in return I feed them interesting things — links to articles, blogs etc.*"

Finally, we discussed using Twitter at conferences. Often, people will attend a conference and will use Twitter to disseminate information about what the speaker is saying. They may voice an opinion about it or comment on the speaker's attire or the lunch offerings. However, this sometimes raises concerns from those attending and speaking. Alok commented that he finds Twitter useful if he can't attend a conference himself, or if a conference has parallel sessions, he can find out what's happening at the session(s) he is missing. He reassured the audience that it doesn't stop him from attending a conference. Alok won't rely entirely on what an audience member has tweeted at a conference. Instead he uses Twitter as a lead rather than a primary source of information. The danger with Twitter comes if conference organisers don't make their Twitter policy clear from the outset. Therein lays a danger that a scientist may present preliminary data which is disseminated incredibly quickly and picked up by a less discerning journalist. So care is needed, but with a changing media environment, people also need to get used to the idea that conferences are no longer only 'attended' by the people who are physically present. The changing face of the media provides scientists with enormous opportunities to publicize their science, either directly, or through more traditional news media channels.

This session provided a taste of these opportunities and I would like to extend an invitation to all readers to comment on some or all of the issues covered here. At least one delegate on the day changed her mind about the utility of Twitter. Perhaps you're the same? Whether this has encouraged you to get more involved or had the opposite effect, I'd like to hear from you.

references

- Batts, S., Anthis, N.J. and Smith, T.C. Advancing science through conversations: bridging the gap between blogs and the academy. *PLoS Biology*, **Vol. 6**, No. 9. e240. http://www.plosbiology.org/article/info:doi/10.1371/journal.pbio.0060240
- Phillips, D. P., Kanter, E. J., Bednarczyk, B. and Tastad P. L. (1991) Importance of the Lay Press in the Transmission of Medical Knowledge to the Scientific Community. *N Engl J Med*; **Vol. 325**: pp1180-1183.

further information

- About SfAM journals: http://onlinelibrary.wiley.com/
- About the Science Media Centre — including links to 'top tips' leaflets: http://www.sciencemediacentre.org/pages/
- About the *Guardian* newspaper online: http://www.guardian.co.uk/
- Ed Yong's blog — Not Exactly Rocket Science: http://blogs.discovermagazine.com/notrocketscience/
- SfAM on Twitter: www.twitter.com/sfamtweets
- Press releases distributed by SfAM: http://www.sfam.org.uk/pressrelease.php
- About publicizing research which hasn't yet gone through the peer review process: http://www.stempra.org.uk/newsletter/10_autumn/07.htm
- Pew research centre for the people and the press: http://people-press.org /reports/

Lucy Harper
Communications Manager

Summer Conference 2010 report

Grand Hotel, Brighton, UK, Monday 5 to Thursday 8 July 2010

The conference began with the Lewis B Perry Memorial Lecture held in the Grand Hotel and presented by Professor Robin Nicholas (Veterinary Laboratories Agency). He gave a fascinating presentation entitled: **Contagious bovine pleuropneumonia: in search of the origins and virulence of lung sickness**, a subject which he has written eloquently about in a previous issue of *Microbiologist* (Vol. 10, No. 4, pp 41-43). All agreed he set the bar high — a great way to kick off what was to become a fascinating few days.

Lucy Harper, Communications Manager

Applied bacteriophage therapy was the topic for Session 1 which was chaired by the Honorary Meetings Secretary, Andy Sails. The first talk, **Phage therapy in human infections** was presented by Dr Alexander Sulakvelidze (Chief Scientist of Intralytix, USA). He reminded us that bacteriophages (phages) are the most ubiquitous organisms in nature, with an estimated 10^{30} – 10^{32} being in existence on Earth.

Alexander summarized the history of our knowledge of phages from 1915 until the present day, including the first therapeutic application by Felix d'Herelle in 1919. He explained that phage therapy has recently received renewed interest due to the escalating problems associated with resistance to antibiotics. He described various potential applications in humans such as their use as probiotics and then concentrated on some successful real applications. PhagoBioDerm, a commercially available wound dressing, is a biodegradable polymer which is impregnated with specific phages to attack common wound pathogens. We were shown images of combat-related injuries which had responded well to this treatment. Although human phage therapy has been used extensively in Eastern Europe and former Soviet Union countries, there is a lack of robust data to prove its efficacy. Alexander therefore concluded his talk with details of some clinical trials of phage-based therapies which are currently recruiting participants in order to provide such data.

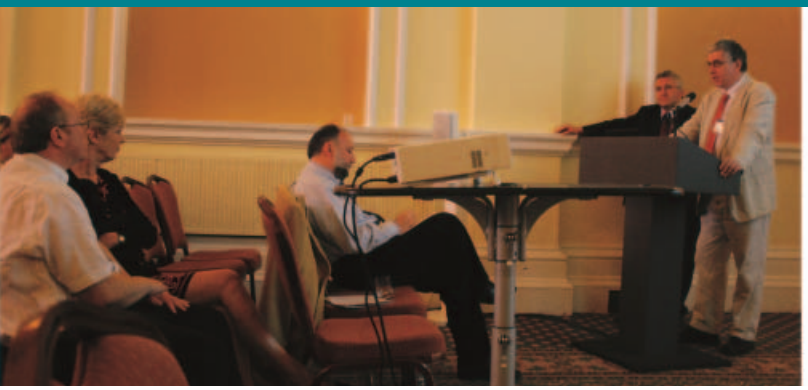
The second talk of the session, **Uses of phage in the animal food production chain**, was delivered by Professor Ian Connerton (University of Nottingham, UK). He focussed particularly on their use against *Campylobacter* spp. in chickens. *Campylobacter* spp. can be recovered from the majority of chickens, including broiler, fresh retail and barn-reared birds, and a large percentage of these are infected by phages. Since members of the public already consume these phages, their use in the biosanitization of food products does not expose consumers to anything new. Ian explained that risk models suggest that a 2 log reduction of *Campylobacter* contamination of chickens could lead to a 30 fold reduction in cases of human infection. He also demonstrated that *Campylobacter* resistance to phage is of less concern than resistance to antibiotics since the phage-resistant isolates are compromized in their ability to colonize chickens and readily revert to the sensitive phenotype.

Dr David Harper (Chief Scientific Officer, Biocontrol Ltd., UK), then gave a presentation entitled **Bacteriophages for the treatment of *Pseudomonas aeruginosa* infections**. He summarized the factors that make *Ps. aeruginosa* a promising target for phage therapy including its multiple resistance to antibiotics and its tendency to grow in biofilms which can be penetrated by phages. David described the trials which were used to evaluate his company's phage cocktail, initially in dogs and then in humans with antibiotic-refractory ear infections. He outlined a further planned trial of aerosol delivery of a phage mixture into the lungs of cystic fibrosis patients with *Ps. aeruginosa* infections. His hope for public acceptance of phage therapy relies on the concept of 'friendly viruses' being viewed in a similar way to 'friendly bacteria'.

Louise Hill-King, Grants Editor

The second half of the **Applied bacteriophage technology** session began with Jason Clark (Big DNA, Edinburgh, UK) discussing **Using bacteriophage to develop DNA vaccines**, genetically modified bacteriophages used as a novel method to deliver DNA vaccines. This delivery system works using a bacteriophage containing the relevant plasmid. This is engulfed by antigen presenting cells where the phage is broken down and the DNA vaccine released into the host cell. Jason's research has shown that phage vaccinated (lambda vector) rabbits responded better than those vaccinated with a protein antigen. Overall, the response to the DNA vaccine was quicker and required lower doses than the protein antigen vaccine. He concluded that using a lambda vector for vaccines has many advantages over current delivery methods. These advantages include humoral and cell mediated responses, also the protein matrix of the viruses is protective and cheap. However, before the commercialization of phages as vaccine vehicles for humans can be considered, safety issues need to be addressed including the presence of undesirable genes in the vector and the ability for genes to transduce into host DNA.

This point was reiterated by Steven Hagens (EBI Food Safety, Netherlands), whose presentation entitled **Bacteriophages for the prevention of *Listeria monocytogenes* in food** outlined the potential uses of phages for the biocontrol of *Listeria* spp. on hotdogs where a 3



This year's Summer Conference was held at the Grand Hotel in Brighton during a sunny week in early July. Despite the temptation to leave the hotel and explore this colourful setting, the three topics on offer: **Bacteriophages**, ***Listeria*** and **Biofilms** proved too gripping for delegates to miss

$\log_{(10)}$ reduction can be achieved using Phage P100 (Listex). The advantages of using bacteriophages as an on-food antimicrobial is that unlike chemicals, selective pressure resistance does not occur. The session then broke for lunch where hotdogs were on the menu! After lunch Martin Loessner (Institute of Food Nutrition and Health, Zurich, Switzerland) presented his research on the **Use of bacteriophages as a novel diagnostic tool**. The use of C-terminal (cell wall binding domain [CBD]) of the phage encoded peptidoglycan hydrolases (endolysins), can be used to recover organisms such as *Listeria* spp. isolating more bacteria and reducing incubation times from 96 hours to 48 hours compared to other more conventional methods. The addition of luciferase reporter phage to CBD can further reduce incubation periods to 24 hours. The last speaker of the session, George Botsaris (Cyprus Veterinary Services, Nicosia, Cyprus) also spoke about **The challenges of using phage in food and veterinary diagnostics**. The use of luciferase in combination with bacteriophages was described and the advantages (rapid, reliable, cheap, standardized and able to differentiate between live and dead cells) and disadvantages (needs registering as a GM organism, public resistance and cost of development) of this approach were explained in its use as a commercial diagnostic tool.

Katie Laird, SfAM Main Committee

The afternoon session, ***Listeria*: new perspectives on an old pathogen**, began with a talk from Jim McLauchlin (Health Protection Agency, UK) entitled ***Listeria* and human listeriosis: emergence and re-emergence**. Jim began with a brief history of the disease detailing how it was originally thought to principally infect animals, before going on to describe the shift in thinking that occurred in the 1980s which led to its recognition as an emerging infectious disease in humans. He continued by outlining the epidemiology of the disease and questioned whether changes in the food chain could be responsible; in his closing remarks he concluded that better legislation and dietary advice were required to protect the general public.

Martin Wagner (Institute for Milk Hygiene, Austria) continued the session by speaking on **The challenge of quantifying *L. monocytogenes***. Martin discussed the growing necessity for a rapid, quantitative approach to the detection of pathogenic microorganisms in food products. He went on to explain that molecular biology based techniques had been developed, but were not in widespread use due to the lack of an adequate method for sample preparation. He continued by describing a novel protocol, termed "matrix lysis", which had been successfully used to quantify *L. monocytogenes* in milk; he finished by suggesting that the same technique could be used for the extraction of a multitude of different microorganisms from food products.

Following this, Kathie Grant (Health Protection Agency, UK) presented **Molecular sleuthing and listeriosis**. She explained that the numbers of cases in people over 60 has steadily increased since 2001, but it was often difficult to investigate individual cases as sufferers are often sick with pre-existing conditions and listeriosis has a long incubation period. She continued by describing how the epidemiology of the disease was being tracked via molecular methods (such as polymerase chain reaction [PCR] and amplified fragment length polymorphism [AFLP]) which assisted national surveillance in the UK. Kathie went on to outline how the next generation of strain typing would need to differentiate between strains based on their pathogenicity and finished by proposing to perform whole genome sequencing on 30 strains to further this goal.

Kendra Nightingale (Colorado State University, USA) gave the next presentation on **Ecology of *Listeria* in the environment and in animals**. Kendra described how *Listeria* is pervasive in our natural environments but that some locations, such as farms, have a higher prevalence of pathogenic strains (i.e. *L. monocytogenes*). She went on to outline a study which used ribotyping to assess *Listeria* transmission in small and large ruminant farms. She concluded that cattle contributed to the prevalence of *Listeria* but that this could be minimized by better farm management practices.

The last session of the day was dedicated towards career advice for student members. Six speakers in total gave short presentations about their respective professions which included working; as a biomedical scientist in the NHS, commercial selling, science communication, a business development manager within a university, a postdoctoral scientist and a lecturer. Talks ranged from typical job activities to routes into the profession and were well received by all.

Phillip Humphryes, PECS Communications Officer

The session: ***Listeria*: new perspectives on an old pathogen** continued on Wednesday morning with a presentation from Colin Hill (University College Cork) entitled **What does not destroy *Listeria*, makes it strong — adapting to stress *in vitro* and *in vivo***. *Listeria* has to adapt to so many different environments from life in food to that in a processing plant, surviving the refrigerator and the bombardment these microbes receive from their human host

in the form of gastric acids and bile. You could almost feel sorry for these humble microbes! Colin described how *Listeria* has adapted to survive this kaleidoscope of microenvironments. Reversible expression of a stress resistant phenotype endowed tolerance to a range of different pressures, indeed, in some cases cross-tolerance to multiple forces. He went on to detail various mechanisms that play an important role in surviving these pressures such as the role of the glutamate decarboxylase GAD system and glutamate in surviving stomach acids and the overarching control of these genes by the stress alternative sigma factor *sigB*. Furthermore, greater diversity among isolates is becoming apparent with some having two copies of the GAD and bile salt hydrolase (BSH) systems, some located upon a 5-gene stress survival island. Some strains belonging to the virulent lineage one also possess two haemolysin systems. This raises the issue as to whether we should incorporate identification of these potential virulence factors rather than a genus or species detection alone. Such considerations as possession of virulence factors, the stress response, host or dietary factors are not yet included within the regulatory standards making their relevance debatable under certain circumstances. To highlight this point, Colin went on to describe the effect of host microbiota upon the infectivity of *Listeria* with *Lactobacillus salivarius* being able to reduce the infectivity of *Listeria* by 99.9%.

The next presentation was provided by Cath Rees (Nottingham University) entitled **Renaissance bacteria — *Listeria* persistence in the food environment**. Cath drew our focus to *Listeria* and its remarkable resilience to adverse situations. Conditions such as low pH, lack of available water, low temperatures or modified atmospheres have all shown little effect against this formidable enemy. The organism has been recovered from remarkable and often unexpected places including ready to eat sandwiches in hospitals, flavoured milk drinks or equipment in factory settings. Compliance with legislative requirements is often done in a responsive mode, with data often now analyzed in detail enabling more proactive environmental cleaning as soon as levels begin to rise. So how can *Listeria* survive in such diverse environments? Its ability to live at cold temperatures is certainly an advantage with the organism able to grow in temperatures ranging from 2 to 45°C. At cooler temperatures, *Listeria* is still able to multiply with a mean generation time of 19 hours. Despite the low temperatures, the organism maintains its membrane fluidity, repairing cold–shock damage to proteins and still successfully undertakes translation. Proteomic analysis has shown significant up-regulation of flagellin genes and cold–shock proteins under cold conditions. Our *in vitro* evaluation of *Listeria* was questioned, as this often utilizes nutritious media such as brain–heart infusion broth. Intriguingly, when these organisms are transferred into minimal media, they produce a capsular slime layer. The implications upon our *in vitro* testing are not yet fully appreciated, but it is possible that laboratory evaluation conditions are not truly representative of the environmental conditions we seek to mimic.

Sally Cutler, *Sf*AM Main Committee

The session preceding the student session on day three of the conference was entitled **Buzzwords in biofilms** and was chaired by Professor Jo Verran from Manchester Metropolitan University. Dr Adam Roberts from UCL Eastman Dental Institute, UK presented a talk entitled **Horizontal gene transfer in oral biofilms**. He was full of praise for the support shown by *Sf*AM to PECS and the students at the conference. He went on to say that antimicrobial resistance is common in human associated microbiota and transient bacteria are detectable in saliva and are able to transfer DNA to resident microbiota.

The session continued with Dr Karin Sauer (Assistant Professor, Binghamton University, USA) who went on to talk about **Biofilm development and dispersion in *Pseudomonas aeruginosa* biofilms**, giving an insight into the regulatory factors associated with formation and growth of biofilms, as well as the proteins involved with dispersion concluding that biofilm development is indeed a regulated process.

The student session followed and was chaired by Professor Geoff Hanlon, Honorary President of *Sf*AM. Five oral presentations were kicked off by Hani Alhadrami (University of Edinburgh) who spoke about **Bioaccessibility of environmental pollutants —** and using biosensors for human health hazard assessment. In his work, he used chemical analysis including a range of mutagenic assays such as Ames and an *in vitro* gastrointestinal bioassay to quantify the bioaccessible and bioavailable fractions of soil pollutants. He concluded that the Ames test was robust and sensitive for soil samples contaminated with environmental pollutants. This was followed by Janet Nale (University of Leicester) who spoke about **Isolation and characterization of temperate bacteriophages of the hyper-virulent *Clostridium difficile* 027 strain**. Janet's study showed that phage carriage within *C. difficile* 027 is highly variable but correlates with the subclades and also suggested that temperate bacteriophages may have a role in their pathogenicity. Rebecca Nicholas (University of Wales Institute Cardiff (UWIC)) then followed with a talk on the **Efficacy of Open Air Factor (OAF) on surface attached environmental *Listeria monocytogenes* serotype 1/2a and *Pseudomonas aeruginosa* isolates**. Rebecca has generated OAF (ozone and d-limonene) using an OAF air disinfection device and found it effective against surface attached Gram-positive and Gram-negative bacteria with *Ps. aeruginosa* more sensitive than Gram-positive *L. monocytogenes*. Her work also demonstrated OAF to be significantly effective against surface attached environmental microorganisms.

Next up was Stanley Onwuje (University of Brighton) who presented a talk on **Immobilization of bacteriophages on to polymer surfaces**. His work explored coupling lytic bacteriophages on device surfaces as a means of controlling infection and showed that chemical coupling to solid surfaces

was possible with the lytic bacteriophages retaining their antimicrobial activity as virus viability was maintained. However, his work highlighted the need for further research to explore stability of coupled phages and activity of phages in *in vivo* conditions.

The final presentation was given by Ben Swift (University of Nottingham) whose presentation was entitled: **An investigation of Gram-positive pathogens in powdered foods**. His work investigated Gram–positive pathogens in powdered foods to determine the levels of organisms both spore forming and non–spore forming in powdered products. Ben's work highlighted a need for information or instructions regarding storage conditions to avoid toxin production and proliferation of organisms in rehydrated products as his work found generally low levels of Gram–positive bacteria. However, in elderly build up products, infective doses were seen with *Staphylococcus aureus* and *Bacillus cereus*.

For the Postgraduate and Early Career Scientists (PECS) and the Student Members, the poster sessions and student presentations at the *Sf*AM Summer Conference are always special and today offered an exciting opportunity for *Sf*AM to showcase the continuous development of its student members with these five excellent oral presentations.

Emmanuel Adukwu, PECS Events Officer

The conference continued well into the evening with a drinks reception overlooking the seafront, followed by the Summer Conference dinner. After a delicious dinner, this year's winner of the *Sf*AM Communications Award, Professor John Oxford (Queen Mary, University of London and London Scientific Director of Retroscreen Virology) was presented with his award. Professor Oxford has many years' experience working with influenza. He has written over 250 scientific publications, a textbook entitled "Human Virology" and has been instrumental in making the recent swine flu pandemic understood by non-scientists. Professor Oxford is a regular contributor to TV news and features programmes including the BBC 10 o'clock news, *Newsnight*, *Today*, BBC News 24, and *Richard and Judy*. He has written or contributed to numerous newspaper articles and has appeared in a number of documentaries including the BBC *Horizon* episode "Pandemic". He entertained delegates after dinner with a fascinating talk where he described his experiences emphasizing the importance of the accurate communication of science.

The final session of the conference was a continuation of **Buzzwords in biofilms**. The first speaker of this session was by Alexander H. Rickard (Binghamton University, USA), who was a recipient of a *Sf*AM New Lecturer Research Grant in 2008. He presented his work on **Autoinducer-2: role in inter-species communication between bacteria indigenous to the human microbiome**. He described how bacteria are social units of life (as we were at the Conference dinner) and biofilm communities are common to the human microbiome. Over 2000 different species can be found in the human body, these being resident commensal or transient pathogenic communities. It is proposed that Autoinducer-2 (AI-2) is the universal signal molecule that mediates communication between different species of bacteria thus controlling their interactions and community development. Alexander explained how AI-2 mediates independence, competition and mutualism between co-aggregating bacteria. Therefore AI-2 has a role in the development of human biofilm communities and the expansion of transient pathogenic communities within the human microbiome.

Daniel Rozen (Manchester University, UK) continued the session by speaking on **Evolution and diversification in bacterial biofilms**. Daniel highlighted how cells benefit from growing within a biofilm and how these advantages are the product of physical architecture of biofilms, whilst others result from the altered physiology of biofilm grown cells. Diversification can be facilitated within a biofilm because of increased spatial structure which leads to subpopulation differentiation and localized interactions. Secreted products which have limited access to clonemates will lead to social evolution within areas of a biofilm. The examples covered in Daniel's presentation highlighted the central role played by the physical structure of a biofilm on bacterial evolution.

The following presentation in this fascinating session was by Tim Tolker-Nielsen (University of Copenhagen, Denmark) on **Subpopulation interactions during *Pseudomonas aeruginosa* biofilm formation**. Tim discussed how the formation of heterogeneous biofilms may occur through mechanisms which involve complex subpopulation interactions. It has been found that the *Pseudomonas* quinolone signal (PQS) system is involved in the release of extracellular DNA in *Ps. aeruginosa* biofilms. By using DNase it can be concluded that extracellular DNA stabilizes biofilm structure. To follow on from this Tim discussed how the inhibition of the PQS system of a *Ps. aeruginosa* biofilm can decrease tolerance to antimicrobial compounds and how quorum sensing inhibitors can be identified through structure based virtual screening.

The final presentation of this session on **Biofilm development as a neoplastic-like mode of microbial growth** was given by Jeremy Webb (Southampton University, UK). Jeremy discussed how biofilms are important foci for genetic change and their development may involve intrinsic processes of clonal selection and expansion. This model for biofilm growth is similar to mutation selection processes that occur during the development of many eukaryotic cancers. Multiple cancer cell lines form biofilm-like microcolonies, known as spheroids, when grown in surface associated culture. Similar to the process of biofilm growth, genetic instability and mutation selection are proposed to be involved in the formation of spheroid structures. From this it may be possible to integrate approaches to bacterial and tumour development by studying parallel processes across these two different systems.

Samantha Law, *Sf*AM Main Committee

12 January 2011

Winter Meeting

- **Probiotics**
- **Anaerobic microbiology**

■ Including the Denver Russell Memorial Lecture

The Royal Society, London, UK

IBMS CPD ACCREDITATION 5 POINTS

Programme

These preliminary programme times and titles were correct at the time of going to press. For the latest programme please visit: www.sfam.org.uk/winter_meetings.php

10.00 - 10.30 **Tea, coffee and registration**

Chair: **Geoff Hanlon**

10.30 - 11.15 **The Denver Russell Memorial Lecture — *Propionibacterium acnes*: emerging pathogen?**
Peter Lambert, Aston University

11.15 - 11.50 **The gut flora and probiotics**
George MacFarlane, University of Dundee

11.50 - 12.25 **An overview of the past 40 years in anaerobic microbiology**
Mike Wren, University College London Hospital

12.25 – 13.30 **Lunch**

Session A: Probiotics

Chair **Martin Adams**

13.30 - 14.05 **Probiotics and the elderly**
Ian Rowland, University of Reading

14.05 - 14.40 **Prebiotics**
Bob Rastall, University of Reading

14.40 - 15.00 **Tea and coffee**

15.00 - 15.35 **Probiotics, prebiotics and neonates**
Christine Edwards, University of Glasgow

15.35 - 16.10 **Veterinary use of probiotics**
Roberto La Ragione, Veterinary Laboratories Agency

16.10 - 16.45 **Safety of probiotics**
Kevin Whelan, King's College London

Session B: Anaerobic microbiology

Chair **Mark Fielder**

13.30 - 14.05 **State of the art regarding *Clostridia***
Ian Poxton, University of Edinburgh

14.05 - 14.40 **The exploitation of beneficial anaerobic microorganisms**
Nigel Minton, University of Nottingham

14.40 - 15.00 **Tea and coffee**

15.00 - 15.35 **Anaerobes in complex polymicrobial diseases**
Martin Woodward, Veterinary Laboratories Agency

15.35 - 16.10 **An overview of identification of anaerobes, including latest developments**
Val Hall, Anaerobe Reference Laboratory, National Public Health Service Microbiology, Cardiff

16.10 - 16.45 **Oral anaerobes**
Peter Mullany, Eastman Dental Institute

16.45 **Close**

To register online for the Winter Meeting please visit www.sfam.org.uk/winter_meetings.php or contact Sally Cryer ■ Email: sally@sfam.org.uk. Telephone: +44 (0)1234 761752

WINTER MEETING 2011 BOOKING FORM and INVOICE

SfAM WINTER MEETING WEDNESDAY 12 JANUARY 2011

Only ONE person per form please. CLOSING DATE FOR REGISTRATIONS: Wednesday 5 January 2011
EARLY BIRD DISCOUNT of £30.00 is applied to all bookings made before **Wednesday 22 December 2010**

Cancellation policy: Up to 30 days prior to the event all cancellations will be subject to a 10% cancellation fee, up to 14 days prior to the event there will be a 50% cancellation fee, and no refunds will be given on cancellations made within 7 days of the event.

***Non–members: You can add 1 year's membership to your event booking using this form, then register at the member rate and spend the same amount of money or less!**

FEES	Before 22/12/2010	Between 23/12/2010 and 05/01/2011
Full member	£50 ☐	£80 ☐
Student member	£30 ☐	£60 ☐
Honorary member	£30 ☐	£60 ☐
Associate member	£30 ☐	£60 ☐
Retired member	£30 ☐	£60 ☐
Student non–member	£60 ☐	£90 ☐
Non–member	£100 ☐	£130 ☐
IBMS members	£75 ☐	£105 ☐

YOUR INTERESTS

Please indicate which of the two afternoon parallel sessions you wish to attend

Session A: Probiotics ☐ **Session B:** Anaerobic microbiology ☐

*ADD MEMBERSHIP TO YOUR BOOKING

Add Student membership (£25.00): ☐ **Add Full membership (£50.00):** ☐

YOUR DETAILS

Title:_____ **First Name:**_____ **Family Name:**_____

Organization/Affiliation:_____

Address:_____

_____ **Postcode:**_____

Tel No:_____ **Fax No:**_____ **Email:**_____

Please indicate any special dietary or other requirements (such as disabled access):_____

YOUR NAME BADGE

Please enter the information below in **BLOCK CAPITALS** as you would like it to appear on your name badge

First Name:_____ **Family name:**_____

Organization/Affiliation:_____

YOUR PAYMENT

● For all participants: **The Society DOES NOT INVOICE for conference fees. Please treat your completed booking form as an invoice. Cheques must be in £ STERLING ONLY and made payable to 'The Society for Applied Microbiology'. Foreign cheques/ drafts MUST be negotiable for the full amount due.** We accept payment **ONLY** by the following credit and debit cards: VISA, Mastercard, Eurocard, Delta, Electron, JCB, Maestro and Solo.

☐ **Cheque enclosed** ☐ **Please charge my *Mastercard/Visa card /Debit card*** *(please delete inapplicable items)*

TOTAL Amount enclosed/ to be charged: £_____

Card number: ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ Solo Cards only: ☐☐☐

Issue No. ☐☐☐ Expiry Date: ☐☐☐☐ Start Date: (*Debit cards only*) ☐☐☐☐

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Signature:_____ Date:_____

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13 April 2011

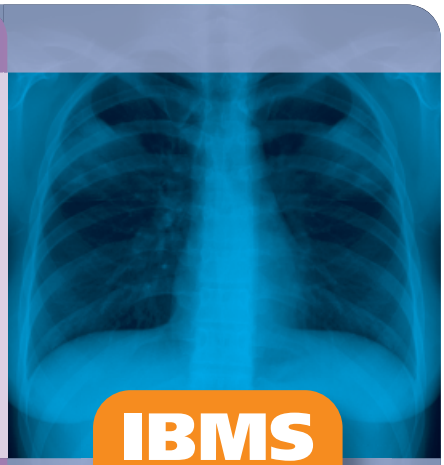
Spring Meeting

5th broadening microbiology horizons in biomedical science meeting

Latest developments in respiratory tract infections (RTIs)

- Including the Procter and Gamble Applied Healthcare Microbiology Award lecture

The Stratford Q Hotel, Stratford upon Avon, UK



IBMS CPD ACCREDITATION 6 POINTS

Programme

These preliminary programme times and titles were correct at the time of going to press. For the latest programme please visit: www.sfam.org.uk/spring_meetings.php

09.15-10.15	**Coffee, trade exhibition and registration**
10.15-10.20	**Chairman's Welcome**
10.20-11.00	**Procter and Gamble Applied Healthcare Microbiology Award lecture** Topic and speaker to be confirmed
11.05-11.35	***Bordetella pertussis*** Norman Fry, HPA, Colindale, London
11.35-12.05	***Legionella* spp** Tim Harrison, HPA, Colindale, London
12.05-12.35	**RTIs in animals** Robin Nicholas, VLA, Weybridge
12.35-14.00	**Lunch and trade exhibition**
14.00-14.30	**RTIs and the paediatric patient** Patricia Fenton, Sheffield Children's Hospital, Sheffield
14.30-15.00	**RTIs and the intensive care patient** John Simpson, Newcastle University
15.00-15.30	**RTIs and the cystic fibrosis patient** Frank Edenborough, Northern General Hospital, Sheffield
15.30-16.00	**RTIs and the immunocompromised patient** Derek Macallan, St George's University of London, London
16.00	**Close, tea and coffee**

To register online for the Spring Meeting please visit www.sfam.org.uk/spring_meetings.php or contact Sally Cryer ■ Email: sally@sfam.org.uk. Telephone: +44 (0)1234 761752

SPRING MEETING 2011 BOOKING FORM and INVOICE

SfAM SPRING MEETING WEDNESDAY 13 APRIL 2011

Only ONE person per form please. CLOSING DATE FOR REGISTRATIONS: Wednesday 6 April 2011
EARLY BIRD DISCOUNT of £30.00 is applied to all bookings made before **Wednesday 16 March 2011**

Cancellation policy: Up to 30 days prior to the event all cancellations will be subject to a 10% cancellation fee, up to 14 days prior to the event there will be a 50% cancellation fee, and no refunds will be given on cancellations made within 7 days of the event.

FEES	Before 16/03/2011	Between 17/03/2011 and 6/04/2011
Full member	£50 ☐	£80 ☐
Student member	£30 ☐	£60 ☐
Honorary member	£30 ☐	£60 ☐
Associate member	£30 ☐	£60 ☐
Retired member	£30 ☐	£60 ☐
Student non–member	£60 ☐	£90 ☐
IBMS member	£75 ☐	£105 ☐
Non–member	£100 ☐	£130 ☐

***Non–members please note:** You can add 1 year's membership to your event booking using this form, then register at the member rate and spend the same amount of money or less!

*ADD MEMBERSHIP TO YOUR BOOKING

Add Student membership (£25.00): ☐ **Add Full membership (£50.00):** ☐

YOUR DETAILS

Title:_____ **First Name:**_____ **Family Name:**_____

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_____ **Postcode:**_____

Tel No:_____ **Fax No:**_____ **Email:**_____

Please indicate any special dietary or other requirements (such as disabled access):_____

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YOUR NAME BADGE

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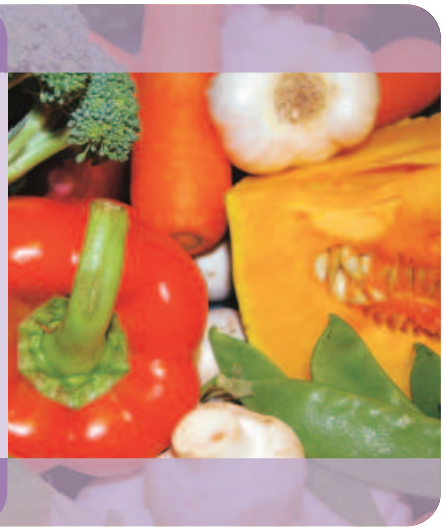
4 - 7 July 2011

Summer Conference

Food microbiology

- Including the Lewis B Perry Memorial Lecture, followed by drinks, buffet and tour of the Guinness Storehouse
- Conference dinner with Irish entertainment and tutored whisky tasting session at the Jameson Distillery



Clontarf Castle, Dublin, Ireland

CALL FOR ABSTRACTS!

- We are now accepting abstracts for posters and the Student session at the 2011 Summer Conference at Clontarf Castle in Dublin. These can be on any topic in applied microbiology.
- There are prizes of **£150**, **£100** and **£50** available to winners of first, second and third prize for posters. For the best student oral presentation there is a prize of **£300!**

For more information or to submit your abstract visit: www.sfam.org.uk/summer_conference.php

STUDENTSHIP GRANTS

- Don't forget that we offer studentship grants to enable student members to attend Society meetings. The grant covers registration, accommodation, meals (where appropriate) and modest travel expenses.
- To be considered for a studentship grant please complete the application form at **www.sfam.org.uk/grants.php**

For more information about *Sf*AM grants visit: www.sfam.org.uk/grants.php

To register online for the Summer Conference please visit www.sfam.org.uk/summer_conference.php or contact Sally Cryer ■ Email: sally@sfam.org.uk. Telephone: +44 (0)1234 761752

Programme

Monday 4 July 2011

11.00-17.00 **Risk assessment workshop in the Great Hall, Clontarf Castle**

17.30 **Coaches leave Clontarf to travel to the Guinness Storehouse**

18.00-19.00 **Tour of the Guinness Storehouse**

19.00-20.00 **Lewis B Perry Memorial Lecture in the Arrol Suite, Guinness Storehouse.**
Alan Reilly, Chief Executive, Food Safety Authority of Ireland

20.00-21.00 **Drinks reception and buffet in the Guinness Storehouse**

Tuesday 5 July 2011

Session 1: Pathogen updates, The Great Hall, Clontarf Castle

09.00-09.35 **Verotoxigenic *Escherichia coli***
Chris Low, Scottish Agricultural College, Scotland

09.35-10.10 ***Campylobacter***
Simon Park, University of Surrey, UK

10.10-10.45 **Foodborne viruses**
Marion Koopmans, National Institute for Public Health and the Environment (RIVM), The Netherlands

10.45-11.15 **Tea and coffee**

11.15-11.50 ***Salmonella***
John Threlfall, HPA, London, UK

11.50-12.25 ***Clostridium***
Mike Peck, Institute of Food Research (IFR), Norwich, UK

12.25-13.25 **Buffet lunch in the Great Hall foyer and reception**

13.25-14.00 ***Cronobacter* spp.**
Seamus Fanning, University College Dublin, Ireland

14.00-14.35 ***Bacillus***
Niall Logan, Glasgow Caledonian University, Scotland

Session 2: Epidemiology of foodborne disease

14.35-15.10 **Current challenges to microbial food safety — estimating the global burden of foodborne diseases**
Claudia Stein, World Health Organization (WHO), Geneva, Switzerland

15.10-15.45 **Food safety in the European Union: ECDC's role in tracking the burden of disease and trends**
Andrea Ammon, European Centre for Disease Prevention and Control (ECDC), Sweden

15.45-16.00 **Tea and coffee in the Great Hall foyer and reception**

16.00-16.35 **Climate Change and the challenge of new pathogens**
Marion Wooldridge

16.35-17.10 **Food safety — the retailer's perspective**
Alec Kyriakides, Sainsbury, UK

17.10-18.10 **Student session**

17.15-19.30 **Trade show with wine, The Great Hall foyer, Clontarf Castle**

19.30-20.30 **Buffet and wine in Indigo Lounge, Clontarf Castle**

20.30 onwards **Quiz night in Indigo Lounge, Clontarf Castle**

Wednesday 6 July 2011

09.00 onwards **Posters in hotel reception**

Session 2: Epidemiology of foodborne disease (continued) The Great Hall, Clontarf Castle

09.00-09.35 **The threat of antibiotic resistance in the food chain for human health**
Hilde Kruse, WHO, Europe

Session 3: Microbiological risk assessment

09.35-10.10 **Recent global risk assessments and impact on Codex standard setting**
Sarah Cahill, Food and Agricultural Organization (FAO), Rome, Italy

10.10-10.45 **Recent developments in *Campylobacter* risk assessment**
Maarten Nauta, Technical University of Denmark

10.45-11.15 **Tea and coffee in reception**

11.00-12.00 **Attended poster viewing**

12.00-13.00 **Lunch**

13.00-13.35 ***Salmonella* risk assessment in Finland**
Pirkko Tuominen, Finnish Food Safety Authority, Finland

13.35-14.10 ***Listeria* risk in butter**
Phil Voysey, Campden, UK

14.10-14.45 **Importance of global and national risk assessments for industry**
Speaker to be confirmed

14.45-15.15 **Tea and coffee**

15.15-16.15 **Student presentations**

16.15-16.45 **W H Pierce Prize**

16.45-17.15 **Annual General Meeting**

18.00 **Coaches leave Clontarf to travel to the Jameson Distillery**

18.30 **Tour of the Jameson Distillery**

19.30 **Tutored whisky tasting session**

19.45-22.00 **Dinner in the Jameson Distillery with Irish entertainment — music and dancing**

22.30 **First coach to take delegates back to Clontarf**

23.00 **Last coach to take delegates back to Clontarf**

Thursday 7 July 2011

Novel technologies to control safety and stability

09.00-09.35 **Novel technologies — overview**
Bala Balasubramaniam, Ohio State University, USA

09.35-10.10 **Pulsed electric fields**
Stefan Toepfl, University of Applied Science, Osnabruck, Germany

10.10-10.45 **Tea and coffee in The Great Hall foyer and reception**

10.45-11.20 **Modified Atmosphere Packaging (MAP) and active packing**
Frank Devlieghere, Ghent University Belgium

11.20-11.55 **High-pressure processing /pressure assisted thermal sterilization (HPP/PATS)**
Alejandro M. Amezquita, Unilever, UK

12.00-13.00 **Lunch and close**

These preliminary programme times and titles were correct at the time of going to press. For the latest programme please visit: ww.sfam.org.uk/summer_conference.php

SUMMER CONFERENCE 2011 BOOKING FORM and INVOICE

SfAM SUMMER CONFERENCE 4 — 7 July 2011

CLOSING DATE FOR REGISTRATIONS: Monday 20 June 2011. EARLY BIRD DISCOUNT of £50.00 is applied to all bookings made before 6 June 2011

Cancellation policy: Up to 30 days prior to the event all cancellations will be subject to a 10% cancellation fee, up to 14 days prior to the event there will be a 50% cancellation fee, and no refunds will be given on cancellations made within 7 days of the event.

FEES BEFORE 6 JUNE 2011	Full Member	Student, Honorary, Associate & Retired Member	Student Non–Member	Non–Member
Full Conference Rate: (inc accommodation)	£250.00 ☐	£200.00 ☐	£400.00 ☐	£600.00 ☐
Conference Rate: (no accommodation)	£100.00 ☐	£50.00 ☐	£100.00 ☐	£200.00 ☐
Conference Day Rate:	£50.00 ☐	£25.00 ☐	£50.00 ☐	£100.00 ☐

FEES BETWEEN 7 JUNE and 20 JUNE 2011	Full Member	Student, Honorary, Associate & Retired Member	Student Non–Member	Non–Member
Full Conference Rate: (inc accommodation)	£300.00 ☐	£250.00 ☐	£450.00 ☐	£650.00 ☐
Conference Rate: (no accommodation)	£150.00 ☐	£100.00 ☐	£150.00 ☐	£250.00 ☐
Conference Day Rate:	£100.00 ☐	£75.00 ☐	£100.00 ☐	£150.00 ☐

Conference Day Rate delegates please tick the day you wish to attend: Mon 4th ☐ Tue 5th ☐ Wed 6th ☐ Thur 7th ☐

RISK ASSESSMENT WORKSHOP: please tick this box if you would like to attend the workshop taking place on Monday 4 July 11.00 – 17.00 ☐

LEWIS B PERRY MEMORIAL LECTURE: please tick this box if you would like to attend the lecture and social event at the Guinness Storehouse on Monday 4 July ☐

QUIZ NIGHT with wine and buffet: please tick this box if you would like to attend at Clontarf Castle on Tuesday 5 July ☐

CONFERENCE DINNER: please tick this box if you would like to attend the dinner at the Jameson Distillery on Wednesday 6 July (extra fee applies) **£50.00** ☐

***Non–members please note: You can add 1 year's membership to your event booking using this form, then register at the member rate and spend the same amount of money or less!**

*ADD MEMBERSHIP TO YOUR BOOKING

Add Student membership (£25.00): ☐ **Add Full membership (£50.00):** ☐

YOUR DETAILS

Title:_____ **First Name:**_____ **Family Name:**_____

Address:_____

Postcode:_____ **Tel No:**_____ **Email:**_____

Special dietary or other requirements:_____

YOUR NAME BADGE

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Signature:_____ Date:_____

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Environmental Microbiology Lecture report

The 2010 *Environmental Microbiology* lecture **'Microbial Resource Management (MRM): the way forward for environmental biotech'** was presented by **Professor Willy Verstraete** from The Laboratory of Microbial Ecology and Technology (LabMET), Ghent University, Belgium. The lecture was a great success and was well attended by many high profile microbiologists

Professor Verstraete, a world leader in the field, discussed how the 'super challenges' facing us in the 21st century could be alleviated with the use of microorganisms. The 'super challenges' Professor Verstraete was referring to, range from climate change to the need for reliable energy sources, the threat of new pandemics and the general demise in environmental quality. The role of microorganisms in these challenges could be crucial.

Professor Verstraete is a firm advocate of the use of mixed microbial communities, no longer the domain of sloppy microbiologists! He and his team use communities of bacteria to produce energy, degrade waste, clean water and kill viruses. These communities come from air, soil, water, and other places including the human gut, as well as that of ruminants. Microbial resources which should be utilized further are available everywhere, from arctic thermophiles to deep sea nitrogen–producing bacteria. Furthermore, bacteria within the intestinal tract of soil–feeding termites are thriving at pH 12. These mixed cultures of bacteria have even been found in polluted sites working together to degrade pollutants such as chlorinated alkanes, the most commonly found contaminants in soil and groundwater. Yet individually the bacterial species are unable to fulfil the same decontamination roles. Professor Verstraete suggested that we should be looking to conserve microbial communities in the same way we preserve single cultures. He then went even further suggesting that these environmental sites should be classified as sites of great scientific interest and protected by UNESCO!

Professor Verstraete said it is no good recreating a community of bacteria if their primary functions within that community are then disrupted. Currently our understanding of this 'market economics' within microbial communities is poor. Professor Verstraete highlighted some other issues with microbial resource management including the need for influx of food within the community and another finding that his team had discovered: within a community 25% of the species of bacteria within a normal ecosystem change every week.

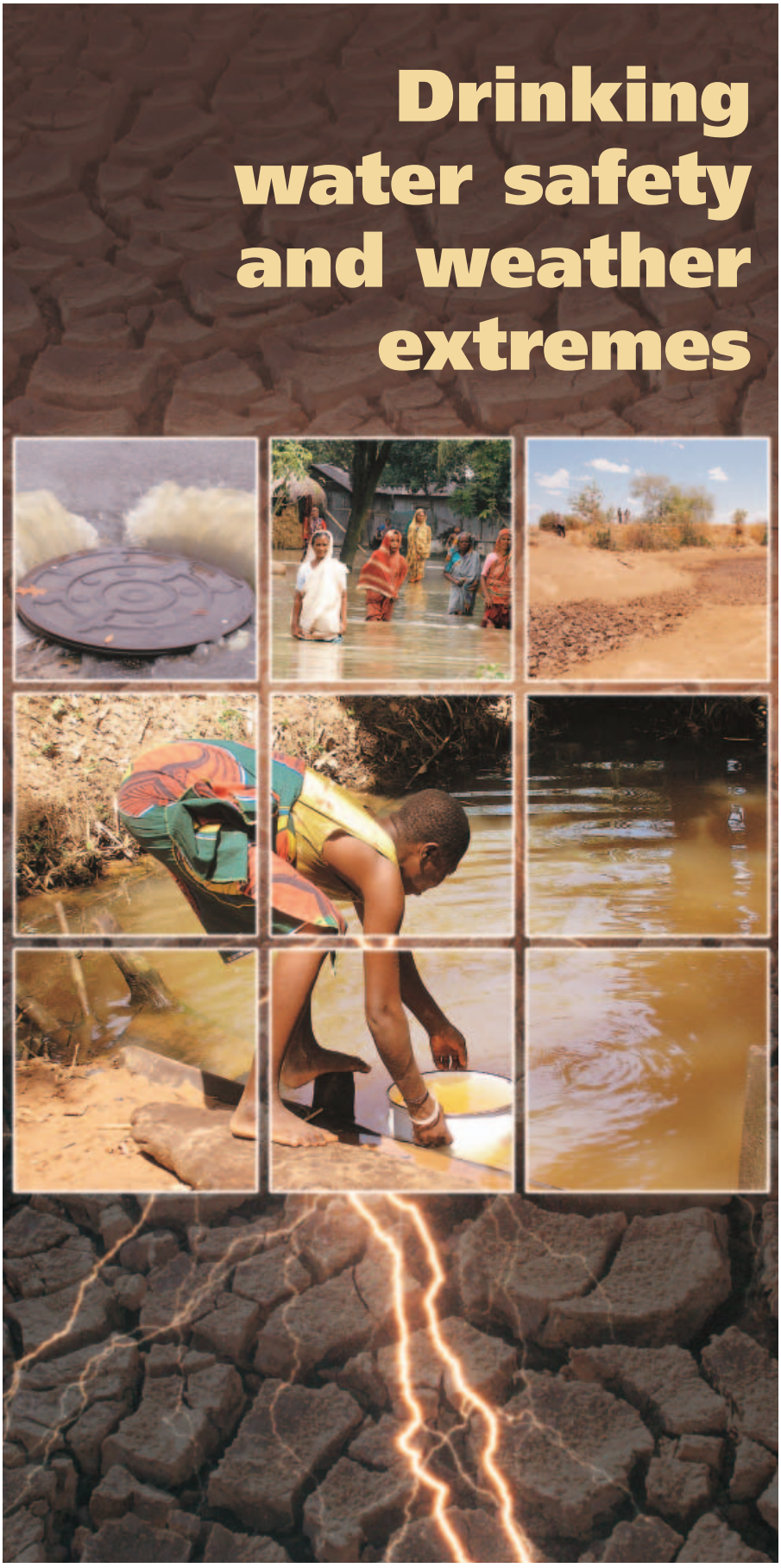
Professor Verstraete finished the lecture with a summary of the ways his team are using biotech solutions to address the super challenges. He discussed ways in which MRM could be used to remove CO_2 from the air and methane emissions from the soil, and as he eloquently put it: "*allow us to continue driving our supercars*!" Professor Verstraete then discussed biofuels and MRM, using the example of the hydrogen produced from microbes to burn a Bunsen burner. Finally he discussed health and disease and how his team were using nanosilver particles initially to kill viruses such as the norovirus using *Lactobacillus* spp. and had now begun to use it against a whole series of organisms including pathogenic bacteria, viruses, algae and fungi.

Professor Verstraete was presented with a commemorative plaque by Ken Timmis, Chief Editor of Environmental Microbiology and Geoff Hanlon, S*f*AM President.

The lecture is now available online here: http://www.yada-yada.co.uk/Blackwell/SFAM2010/SFAM2010.html.

Clare Doggett
Communications Officer

Drinking water safety and weather extremes



Although the precise details will vary from one region to another, models of future climate indicate that we are likely to see major changes in weather patterns throughout this century. A recurrent theme in most models is the probable increase with the frequency of extreme weather events such as increased heavy rainfall on the one hand and more prolonged and seasonal droughts on the other. Heavy rainfall may or may not lead to flooding as has recently been witnessed in Pakistan. This article discusses the impact of such events on drinking water quality and safety. Most evidence of rainfall impact is related to increased rainfall and this shall be discussed first.

Impact of increased rainfall

There is a strong link between rainfall and faecal pollution of drinking water, as measured by the presence of *Escherichia coli*. Though this evidence comes from rainfall in small rural and inadequately treated water supplies (Richardson *et al.*, 2009). In analyzing some 35000 samples collected from private water supplies in England and Wales, we showed a strong association between rainfall on the day prior to the sample being taken, and the probability of detection of *E. coli*. Indeed, we demonstrated that after days with particularly heavy rain, the probability of a sample being positive for *E. coli* doubled. Other workers have shown that levels of protozoan parasites, *Giardia* and *Cryptosporidium*, are also elevated after rainfall events (Kay *et al.*, 2007). However, this data comes from small private supplies which are certainly not typical of the mains drinking water that most of the population of the UK actually drink.

Further evidence of the impact of heavy rainfall on drinking water safety comes from the analysis of epidemiological data. Perhaps the most convincing evidence comes from the demonstration of links between outbreaks of waterborne disease and prior heavy rainfall events. The most influential study reviewed 548 waterborne outbreaks that occurred in the United States between 1948 and 1994 (Curriero *et al.*, 2001). The authors found that 51% of outbreaks were preceded by precipitation events above the 90th percentile (P =.002), and 68% above the 80th percentile

(P=.001). As would be expected the strongest association with extreme precipitation was for outbreaks linked to surface water source. There was also an association with ground water, though with an average two month delay prior to outbreak. Such an association has also been demonstrated in the UK (Nichols *et al.*, 2009).

In our own systematic review of European outbreaks we also found that many were preceded by heavy rainfall (Risebro *et al.*, 2007). However, in our study we used fault tree analysis to identify all the factors that led up to the outbreak. Heavy rainfall was rarely, if ever, the sole problem. Outbreaks only usually follow heavy rainfall if there are other long standing or temporary failures in water treatment, such as poor design of the water treatment works, or temporary failure in filtration. A classic example of such an outbreak was the Walkerton outbreak of *E. coli* O157 (Hrudey *et al.*, 2003). This outbreak was caused by contaminated cattle faeces being washed into drinking water wells following rainfall. This led to 2300 cases of infection and seven deaths. The Walkerton outbreak would not have happened if the supply managers had been taking their responsibilities seriously and were properly maintaining and monitoring their system.

However, most cases of diarrhoea are not associated with an identified outbreak and it is likely that the greatest contribution to the burden of waterborne disease comes from endemic illness. Unfortunately it is much more difficult to get a handle on these sporadic infections. Epidemiological evidence of the relationship between climate and endemic disease risk is most strong for cryptosporidiosis where rainfall was shown to be associated with reported cryptosporidiosis cases (Naumova *et al.*, 2005, Lake *et al.*, 2005). The study by Lake and colleagues is particularly important as it showed that the association between reported cryptosporidiosis and rainfall was not consistent throughout the year but strongest in spring. The suggestion is that rainfall will have most effect when soil moisture is such that immediate run off occurs. Where soils are not saturated, rainfall soaks into the ground and moves through the subsurface which will then filter out *Cryptosporidium* oocysts. The study by Naumova *et al.*, (2005) also found that the association between heavy rainfall and cases of cryptosporidiosis was only seen in communities whose main water supply was unfiltered surface water. One French study looked at the relationship between sales of anti-diarrhoeal drug and both residual chlorine and tap water turbidity in Le Havre (Beaudeau *et al.*, 1999). In a time series analysis they found that both chlorination failures and increases in turbidity were associated with increased drug sales. The water for the city came from karstic aquifers that are prone to episodic deterioration in quality as measured by turbidity especially after heavy rain. At least one of the two water treatment plants for the city did not filter water, but only undertook chlorination treatment. Some of the chlorination failures could also be explained by heavy rain as an increase in turbidity is often associated with an increase in chlorine demand.

Following flooding events, even large scale water treatment and distribution systems can be compromised. Perhaps the most obvious recent example in a developed country was the disaster that befell New Orleans as a result of hurricane Katrina in 2005. Studies of water quality after the event reported high levels of faecal indicators in surface waters but surprisingly none in tap water samples, suggesting that a well maintained water distribution system can be surprisingly robust (Schwab *et al.*, 2007). However, those people who were reliant on wells for their drinking water would have been less fortunate, as there was evidence of substantial contamination of well water at the time (van Biersel *et al.*, 2007).

In the UK, flooding of the River Severn in Gloucestershire in 2007 led to failure of the power supply for 48 hours and inundation of the water treatment works led to the inability to supply water for several days. Even after restoration of the supply consumers were initially advised not to drink their tap water even after boiling. One unusual example of an outbreak following flooding of a water treatment plant was of *Acanthamoeba* keratitis in Iowa (Meier *et al.*, 1998).

Impacts of reduced rainfall and drought

Although models predict increased heavy and extreme rainfall events, many parts of the world may be prone to drying and droughts are likely to become more common in a warmer world. The impact of droughts on health through reduced access to water in affluent countries is not clear. Even in very severe droughts, such as the recent one that affected Barcelona, people's basic requirements for water consumption, personal hygiene and sanitation are likely to be met. As eventually happened in Barcelona, water can be shipped from other areas and indeed other countries if necessary.

The impact of higher temperature and reduced rainfall on water quality is still somewhat uncertain. One issue for which there is a general consensus is that cyanobacterial blooms are likely to become more prevalent in hotter and drier summer (Johnk *et al.*, 2008). Cyanobacterial blooms can cause significant health problems to people reliant on these water supplies but again a well managed water treatment plant should be able to remove toxins (Hunter 1998).

One group that may be particularly adversely affected are those people reliant on small privately owned water systems especially in rural settings where connection to the mains water distribution network is not feasible. In prolonged drought preferred water sources may dry up and people resort to alternate sources of poorer quality, or have to incur the costs of buying in water by bottle or container. Those people with small systems taking their water from surface lakes and reservoirs may be particularly vulnerable to cyanobacterial blooms.

Impact of weather extremes in low income countries

The impact of extreme weather events in low income countries is often much more severe than in the affluent western world. Both rainfall and temperature have a marked impact on the incidence of cholera in Bangladesh (Hashizume *et al.*, 2010). However, this impact is not necessarily linear and both particularly low and high rainfalls affect disease incidence.

The effects of drought on the health of people in resource-poor countries are likely to be much more dramatic than that seen in richer nations. The most obvious impact of prolonged drought in these settings will be the impact on food availability. In the absence of

international aid, food prices may increase, leading to malnutrition in the poorest people. Drought will also reduce the availability of water sources. For those people living in remote areas, wells and surface water sources may dry up and so people will have to turn to local water sources of poorer quality that would not normally be used. They may also need to walk further to collect their water.

There is some evidence that the further people travel to collect water the more likely they are to report diarrhoea (Wang & Hunter, 2010). In low income countries, the main risk from increased water scarcity is likely to be from water washed diseases. In this regard one disease, trachoma, has been shown to be more prevalent in people who live further away from their source of water (Baggaley *et al.*, 2006).

The impact of floods in developing countries is much more dramatic than that seen in the west. The probability of epidemics following floods is much greater. Epidemics of cholera, non-cholera diarrhoea, hepatitis E and malaria have all been reported to follow floods (Hunter 2003). It was not long before cholera was reported after the start of the recent floods in Pakistan (Siva 2010).

Conclusions

The evidence is strong that heavy rainfall events impact on drinking water quality and risk of disease to consumers. It is also likely that prolonged droughts will also impact on disease risk to consumers. However, except in very severe weather events, almost all of the risk will be on people consuming water from systems with inadequate infrastructure (Confalonieri *et al.*, 2007). In the wealthier nations this will be people reliant on small and very small drinking water systems. In Europe people reliant on private supplies will be particularly vulnerable. In low-income countries the impact is much more severe and will be felt by a much greater proportion of the population.

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The microbiology of flooding: homes and health

Urban flooding can result in a number of health impacts, the most obvious of which is drowning. Less obvious impacts are long-term effects such as increased levels of anxiety and mental health problems. Lorna Fewtrell looks at short–term infection risk as a result of urban flooding

Despite interest in the media ("The Toxic Tide: Floodwater rife with killer bugs" The *Sun*, 2007) there is relatively little information available on the microbial 'quality' of floodwater. This article looks at likely pathogens present in floodwater by examining the literature on the component flood flows and outlining some limited floodwater sampling data; these data are then applied using quantitative microbial risk assessment (QMRA) to estimate the incidence of flood-related stomach upsets.

Floodwater components

Urban flooding in the UK is often made up of a number of key components that contribute in different ways to the microbiology (and hence infection hazard) of the floodwater. These are illustrated in Figure 1 and

outlined in more detail below (Fewtrell *et al.*, 2010).

Combined sewer overflows

Combined sewer overflows (CSOs) carry both domestic sewage and stormwater. Under heavy storm conditions, they will discharge into a local watercourse (or the sea) to relieve pressure within the sewerage system and reduce the likelihood of sewage backing up into peoples' homes. They have been identified as an important component of microbial discharge from urban areas, representing a mixture of raw sewage, stormwater microbes and combined sewer sediment.

Sewage

A component of flood volume may consist of raw sewage where, for example, a blockage has occurred in a foul sewer system (or following the overflow of a CSO). The occurrence and concentration of pathogens in raw sewage may vary, both temporally and spatially, depending on the catchment, the size of the contributing population and their health status. The proportion of raw sewage in a sewer overflow will also depend on the nature of the blockage or the size of the capacity breach and the dilution effect in the floodwaters. Treated wastewater may also be a component of a flood flow after discharges from wastewater treatment works (WwTW) into receiving waters, or where heavy rainfall has resulted in overloading of the WwTW. Effluent from WwTW will have undergone treatment to some extent, but such treatment is not generally designed to remove or inactivate pathogens.

Urban 'non–foul' and roofs

In theory, urban non–foul sources should not contain a foul (sewage) element but, as a result of cross connections and the localized use of dual manholes, they often do (O'Keefe *et al.*, 2005). Non–foul urban runoff may also contain pathogens from a range of sources, such as bird droppings and dog faeces.

Rural point source & diffuse sources

Microbial pollution from rural catchment sources is likely to predominate in upstream areas and be transported downstream to larger urban areas by river networks. Diffuse microbial sources, such as runoff associated with grazing land are often supplemented by applications of slurry, farmyard manure and sewage sludge to arable land, as well as contamination from point sources such as runoff from farmyards (Crowther *et al.*, 2002; Edwards & Kay, 2008).

Rivers

Rivers receive microbial pollution from a number of sources, including most of the components shown in Figure 1. The relative contributions from each component (in terms of water volume and pathogen concentration) will vary according to antecedent rainfall patterns, season and catchment characteristics.

Pathogens and floodwater components

A review of the literature (Fewtrell *et al.*, 2010; Fewtrell *et al.*, under consideration) revealed a wide range of possible pathogens present in floodwater. These are shown, by flood component, in Table 1. Unsurprisingly, the pathogens outlined in Table 1 are generally those microorganisms for which routine tests are available. Thus, the absence of a 'yes' for any entry may,

Figure 1. *Component flood flows (adapted from Fewtrell et al., 2010)*

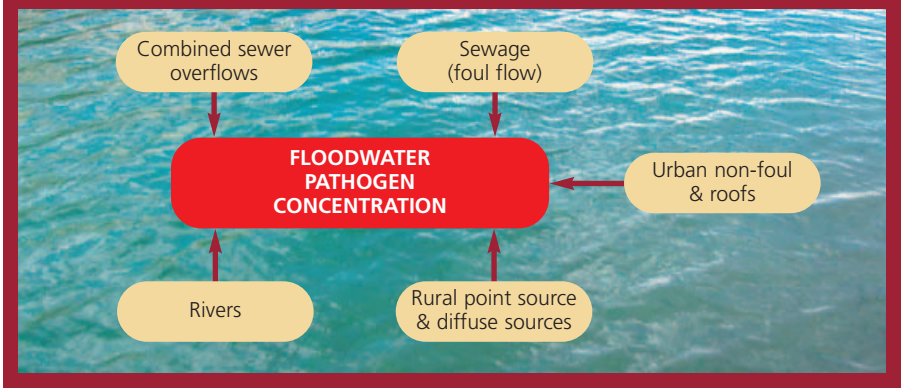

Table 1. Pathogens by flood component (adapted from Fewtrell *et al.*, 2010)

	Pathogen	CSO	Sewage	Urban non–foul & Roofs	Rural	Rivers
Bacteria	*Aeromonas*			yes		yes
	Campylobacter		yes	yes	yes	yes
	***Escherichia coli* O157**		yes			yes
	Helicobacter pylori		yes			yes
	Legionella			yes		
	Listeria		yes			yes
	MAC			yes		yes
	Pseudomonas		yes	yes		yes
	Salmonella	yes	yes	yes		yes
	Staphylococcus			yes		
	Yersinia				yes	yes
Protozoa	***Cryptosporidium***	yes	yes	yes	yes	yes
	Giardia	yes	yes	yes	yes	yes
Viruses	Adenoviruses		yes			yes
	Astrovirus		yes			yes
	Enterovirus		yes	yes		yes
	Hepatitis A		yes			yes
	Norovirus		yes			yes
	Rotavirus		yes			yes

Pathogens shown in bold have been identified in flood components from the UK literature. MAC, *Mycobacterium avium* complex

Table 2. Pathogen concentrations (adapted from Fewtrell *et al.*, 2008)

Reference pathogen	Concentration (cells / litre)	
	River	Sewage
Campylobacter	0.3300	10-180,000
Cryptosporidium	0-59	1-96
Virus	1-64*	70-3200

*Based on a 50th of the sewage value

in many cases, mean that investigators have not looked for that particular pathogen or it is difficult to isolate in that component. Notable microorganisms missing from Table 1 include *Leptospira* and *Shigella*, both of which are likely to be found in some flood components in the UK.

Routes of exposure

A person may be exposed to microorganisms in floodwaters and sediments through various routes during the flood itself, throughout any clean-up procedures and also, in some cases, after the remediation period when flooded residences are re-inhabited. Exposure may be via three main pathways: skin (wound) infection, inhalation and ingestion.

Skin or wound infection is most likely to occur during the flood (e.g. evacuation) or early remediation work, when people would, potentially, be directly exposed to and experience contact with the floodwater. Reports of flood-related infection via this route, however, are uncommon.

Inhalation of microorganisms may occur during flooding and the remediation period, via floodwater sprays and airborne water droplets. It is also possible that some pathogens, such as noroviruses and *Mycobacterium avium* complex (MAC) may remain in house dusts after the floodwaters have dried, although there is little evidence to suggest significant survival of these pathogens.

In terms of likely infection in any flooded population, the most probable route of exposure to flood–associated pathogens is by accidental ingestion. There is epidemiological evidence of infection resulting from direct contact with floodwaters (Schmidt *et al.*, 2005). After the cessation of flooding and the completion of the clean–up process, ingestion of soil may be a potentially important route of exposure to flood–deposited pathogens, via recreational activities, gardening and the consumption of homegrown foods (Davis & Mirick, 2006). Young children may be at particular risk of pathogen ingestion from soils due to their mouthing behaviour and frequent hand-to-mouth contact. As discussed on page 34, the ingestion of contaminated water supplies, particularly where private potable supplies are used in inundated areas, may be a significant exposure risk (Kay *et al.*, 2007).

Flooding, gastrointestinal infection and QMRA

Many of the pathogens outlined in Table 1, and hence likely to be present in floodwater, cause gastrointestinal infection. Although data on a number of gastrointestinal infections are routinely collected in the UK, ascribing illness to an actual flooding event is difficult. QMRA can be used to provide an estimate of flood–related infection risk. QMRA, which was outlined in *Microbiologist* (Schaffner, 2010), is a formal probabilistic process for estimating microbial risks within defined scenarios. The four steps of QMRA are outlined below in relation to estimating the risk of gastrointestinal illness from flooding.

Hazard characterization

There are far too many pathogens, and a lack of data about most, to consider all possible causes of gastrointestinal infection that could be present in floodwater. A common approach is to consider a number of reference pathogens, usually consisting of a bacterial, viral and protozoan pathogen. Suitable reference pathogens are usually those that present a worst case combination of high occurrence, relatively high concentrations in floodwater components and high pathogenicity. Suitable reference pathogens from floodwater include *Campylobacter*, *Cryptosporidium* and a 'composite' virus based on concentrations of adenovirus (which can be determined by cell culture) with the dose–response characteristics of rotavirus.

Dose-response assessment

For microbial hazards the dose-response characterizes the relationship between exposure and the incidence of the health effects, as exposure to the hazard does not necessarily mean that a health impact is inevitable. In many cases, depending on what dose is received and how, the body may be able to remove the pathogen without any obvious ill effect. Dose–response relationships are typically characterized by exposing a population of healthy volunteers (usually young healthy people) to various concentrations of the microorganism under investigation. The results are then modelled (generally using exponential and beta–Poisson models) to enable extrapolation to low doses. The dose-response parameters for the reference pathogens are based on values from the literature (Haas *et al.*, 1993; Medema *et al.*, 1996; Teunis *et al.*, 1996).

Exposure assessment

The demographic profile of the flooded population will be case-specific. To examine the risk of gastrointestinal illness a hypothetical scenario was based on the assumption that 400 houses were flooded with the population characteristics based on an urban population in the north of England. It was assumed that the homes were flooded with a mixture of river water (80%), raw sewage (10%) and urban runoff (10%). The pathogen concentration ranges for the riverine and foul flow components, shown in Table 2, are based on a combination of literature and experimental data (Fewtrell *et al.*, 2008). The urban runoff was assumed to act as a diluting component.

Exposure was assumed to occur during evacuation and during the flood clean-up process, although only the clean–up results are shown here. The initial clean–up process (when people are likely to be exposed to pathogens) was assumed to last between one and four days. Daily floodwater contact during this period was assumed to be the length of a working day (up to 14 hours, with a mean daily exposure of seven hours). It was assumed that,

where possible, young children (under five) would be kept away from the flood clean–up.

The volume of floodwater accidentally ingested is difficult to quantify. Westrell *et al.*, (2004) assumed an ingestion of 1ml in children playing near a source of reused wastewater and transferring water from hand–to–mouth. Tanaka *et al.*, (1998) assumed that a golfer exposed to a course irrigated with wastewater will ingest 1ml in a single exposure. Based on these figures, it has been assumed that in a clean–up situation both adults and children will ingest 1ml per hour.

Risk characterization

Risk characterization brings together the estimates of exposure and dose-response for each of the identified hazards to provide an overall estimation of the risk of illness. Considering the mean values in the flooded population (n=1028), it is estimated that seven people will suffer from campylobacteriosis, 38 people will suffer from viral enteritis and less than one person will suffer from cryptosporidiosis as a result of the clean–up process. The main risk of infection is during the clean–up process with only two people estimated to be ill as a result of the evacuation process.

Discussion

While most gastrointestinal illness contracted from floodwater is likely to be relatively mild and short–lived, these results suggest that a significant number of the flooded population are likely to be affected (over 4% of the population). These estimates do not account for the use of protective clothing, such as gloves, during the clean–up, nor do they allow for the die–off of pathogens during the clean–up process.

Good hygiene precautions are vital to minimize the contact with pathogens and it is suggested that allowing floodwater to drop to very low levels before starting the clean–up process will reduce pathogen exposure through increased microbial die off and decreasing the possibility of splashing.

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Q & A — is *E. coli* O157:H7 affected by rainfall?

In September 2010, Mr **Pete Money** and colleagues published a review in the S*f*AM journal *Environmental Microbiology*. The review looked at mapping *E. coli* O157 in England and Scotland and how incidence of outbreaks is affected by seasonal variation, weather and water

Q Why is *Escherichia coli* O157 infection important?

A *Escherichia coli* O157 is a very important organism. As well as the normal gastrointestinal complaints of infection like sickness and diarrhoea, it can cause bloody diarrhoea, and complications which can potentially cause kidney failure and other kidney problems (haemolytic uraemic syndrome), and in some cases even death. The Godstone farm incident happened as we were working on the project which led to this article for *Environmental Microbiology*. It was an interesting case, emphasizing the potential importance of our conclusions. It was the biggest outbreak in the UK for many years in terms of numbers of people infected — I recall approximately 90 individuals, mostly young children, were infected through contact with animals and faecally contaminated material at the farm. The outbreak took place during the busy summer months when this type of attraction has many young visitors, putting many people at risk of exposure to infection with this organism.

The reason we selected *E. coli* O157 in preference to the more common causes of foodborne infection, such as *Campylobacter*, was more to do with the potential impact of this organism, particularly on young children and the elderly. As I mentioned, *E. coli* has severe complications, whereas the complications which arise through infection with *Campylobacter* tend to be rare and generally much less severe. Most significantly, *E. coli* O157 is recognized to have a low infective dose, unlike many other foodborne organisms. This aspect makes this organism quite challenging to detect in the environment and when investigating disease outbreaks. Any accompanying information such as associated weather mapping patterns can only help in managing the risk of exposure to *E. coli* O157.

Q Why did you consider it important to study the effect of weather on mapping the spread of a disease? One normally thinks about travel patterns of host organisms or products rather than weather?

A We did consider a number of aspects affecting the incidence of *E. coli* outbreaks. Initially we looked at the different phage types of *E. coli* and their geographical distribution throughout the UK and found the same phage type in all locations, yet there appear to be more outbreaks of *E. coli* 0157 in some parts of the country when compared to others. So we specifically wanted to assess the potential effects of rainfall on the spread of *E. coli* in different geographical areas. In the review we have covered quite a lot of work on relationships between rainfall and potential for infection. One of the best examples that links events such as rainfall with this organism is the study carried out by Ogden (2002) and colleagues that very nicely showed the link between *E. coli* infection and heavy rainfall, on a field that held circa 300 head of sheep. The ground was subsequently used for a scout camp where some of the scouts were infected with *E. coli* O157. There were a number of sheep that were shown to be positive for the organism and the whole area was shown to be contaminated, probably as a result of the heavy rainfall in the area and the subsequent human and animal traffic. Further investigations showed that the organism was present in the soil, the sheep faeces, standing water and the scout climbing frame.

Q *Escherichia coli* can survive in a variety of different environments — what are these environments and how does *E. coli* adapt for survival?

A *Escherichia coli* is a very hardy organism and can survive in a variety of temperature and pH environments, especially in faeces and faecally contaminated water and soil. Work by other researchers in the area has shown that this organism can survive for extended periods in environments such as soil and of course it can survive on surfaces, in kitchen environments for example, so cross-contamination can be a problem. Interestingly, the organism has been shown to survive in cold water for long periods, which suggests that this might mean that a state of viable but non-culturable might exist. Other work has also shown that the organism continues to be virulent in the environment with researchers showing that the organism continues to produces both VT1 and VT2 toxins in faeces post-excretion. This is potentially a very 'fit' pathogen.

Q In the review, you mention survival of *E. coli* at summer festivals — have there ever been documented cases of outbreaks at festivals?

A There have been several cases both in rainy parts of Europe and the United States but the names of the festivals involved have not been mentioned, of course. In one study, seven people were infected and an eighth person had a suspected *E. coli* infection which they concluded was caught through contamination of the festival area with faeces from cattle [Knowing what festival toilets are like I can't imagine anything worse than contracting *E. coli* at a festival — Ed].

Q Why does *E. coli* appear to increase in incidence/prevalence during the warmer months?

A This is more than partly down to the activities of the host organisms (us)! We spend more time outside during the summer, for example on camping holidays. There are also seasonal patterns in our eating behaviour with changes in the way in which we prepare and eat food, as well as changes in the locations at which we eat — having barbeques for example. Also, countryside animals show greater faecal shedding during warmer months. The presence of more vectors of disease such as house flies may also contribute to seasonal variation in infection.

We are also seeing an increase in the number of UK residents using camping as an economical holiday option in light of the current economic climate. So we may see a further increase in the number of outbreaks of *E. coli* infection as a result of contamination from faecal shedding of cattle or sheep.

Q Does the weather have a part to play in this seasonal variation — temperature and/or level of rainfall for example?

A The increased temperature allows *E. coli* to survive for longer and we have seen that spreading of the organism to areas regularly frequented by humans can take place through rainfall. But overall there are a large number of contributing factors which result in this increased incidence of *E. coli* during the warmer months in England and Scotland. For instance, some workers have shown that daylight can be more closely correlated to faecal shedding than ambient temperature and this has been supported by studies using artificial light to alter day length. The artificial light studies showed that shedding remained at a constant level in the animals with lighting and decreased in those with no artificial lighting. This could of course be correlated to daylight patterns in the warmer months. This light related issue raises some interesting suggestions and hypotheses by some workers about the role of hormones such as melatonin, but I think more work is required in this area.

Q What other work is required in this area?

A This study indicates that heavy rainfall and/or localized flooding in certain areas of the country, especially where animals are housed/farmed, might reasonably lead to increased outbreaks of *E.coli* infection in certain areas. However, to make this statement definitive, a postcode study in terms of infected people and animal location, correlated with local and national weather patterns would need to be carried out. This is something Dr Mark Fielder's group at Kingston University are looking to undertake.

further information

■ To find out the full story, see: Money, P., Kelly, A. F., Gould, S. W. J., Denholm–Price J., Threlfall, E. J. and Fielder M.D. (2010) Cattle, weather and water: mapping *Escherichia coli* O157:H7 infections in humans in England and Scotland. *Environmental Microbiology*, **Vol. 12** No. 10 pp2633-2644.

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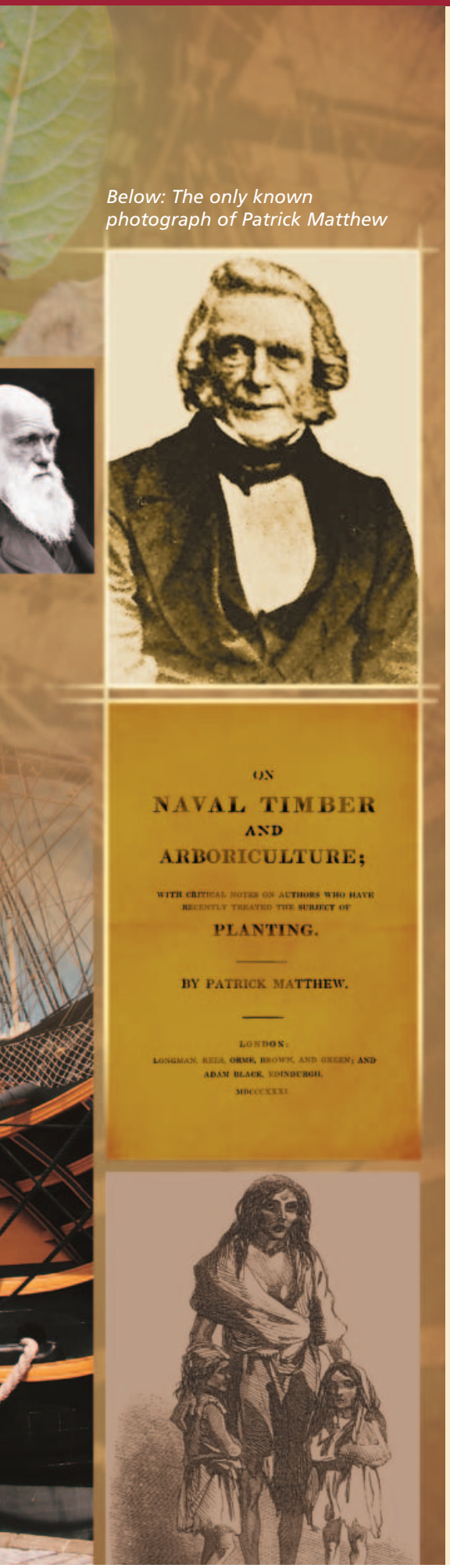
Above, left to right: Louis Pasteur, Alfred Russel Wallace and Charles Darwin

Patrick Matthew: from natural selection to the germ theory

Milton Wainwright tells the story of a Scottish fruit farmer who both Charles Darwin and Alfred Russel Wallace admitted beat them to the theory of natural selection and who went on to publish on the animalcular theory of disease before Louis Pasteur



Below: The only known photograph of Patrick Matthew

Until recently, few people had heard of Patrick Matthew. His name would occasionally appear in biographies of Charles Darwin, but for a long time it looked like he would remain a footnote in the history of biology. However, during last year's bicentennial of Darwin's birth a thorough examination was made of all things Darwin, and Patrick Matthew's name began to be mentioned more frequently, simply because, as both Darwin and Alfred Russel Wallace admitted, Matthew had beaten them to the idea of natural selection. The reputation of any natural philosopher would be enhanced by originating natural selection before these two great Victorian naturalists but, as we shall see, Matthew went even further and published ideas on the germ theory, which predates those of Louis Pasteur. In coming up with novel ideas about evolution and the germ theory before the accepted "giants" in these fields Patrick Matthew clearly deserves our attention.

Who then was this revolutionary thinker, Patrick Matthew? Born into a rich family in 1790, Matthew attended Edinburgh University, but left without taking a degree to return to his birthplace and ancestral home near Errol, a small town lying in the fertile Scottish farmland between Dundee and Perth. Here he grew apples and pears and became renowned for producing new varieties by grafting. His reputation as an arboriculturalist, was sealed with the appearance, in 1831, of his major work, *On Naval Timber and Arboriculture*, the appendix of which contains his ideas on natural selection which clearly predate Darwin's and Wallace's published work on the subject. "Naval Timber" was an extremely important book in a time when the best wooden sailing ships were needed for Britain's defence and to extend her Empire. The book also contains novel ideas about fungal diseases of plants and even makes an oblique reference to mycorrhizae. In the early 1860s, Matthew would go on to publish equally revolutionary ideas on the role of animalcules as causal agents of human disease, and in plants, notably in relation to the potato blight; a fungal disease which caused devastating famine in Ireland in the 1840s and 1850s and was still doing so in Scotland as late as the early 1860s.

Patrick Matthew and natural selection

Although Charles Darwin is almost universally credited with originating the idea of natural selection there is no doubt whatsoever that Patrick Matthew got to the idea before him. How can we be so certain of this? The answer is simple — as the following quote shows, Darwin himself admitted as much in the 4th edition of *The Origin of Species*: "*In 1831, Mr Patrick Matthew published his work on Naval Timber and Arboriculture, in which he gives PRECISELY the same view on the origin of species as that propounded by Mr Wallace and myself in the Linnean Journal, and as that enlarged in the present volume.*" No ifs and buts here. According to Darwin, Patrick Matthew gave "precisely" the same view of natural selection as his own, but in early 1831, that is before Darwin even set foot on the Beagle.

A bolt from the blue

On April 10, 1860, Charles Darwin wrote a letter to Charles Lyell in which he mentions a depressing fact, one that he almost certainly hoped he would never have to admit — he had learned that someone had beaten him to the

theory of natural selection and there was simply no way of avoiding the fact. The letter which Lyell received from Darwin was factual, rather than emotional (Darwin, 1860a): "*Now for a curious thing. In Gardeners' Chronicle, a Mr Patrick Matthews* [Darwin here incorrectly spells Matthew's name] *publishes long extracts from his work on 'Naval Timber & Arboriculture' published in 1831, in which he briefly, but completely anticipates the theory of natural selection — I have ordered the book, as some few passages are rather obscure, but it is, certainly I think, a complete but not developed anticipation! Anyhow, one may be excused for not having discovered the fact in a work on 'Naval Timber*."

Darwin wrote similar letters, admitting Matthew's priority to J. D. Hooker and the American naturalist, Asa Gray. He then published a letter in the *Gardeners' Chronicle* on April 21, 1860 stating that: "*I freely acknowledge that Mr Matthew has anticipated by many years the explanation which I have offered of the origin of species, under the name of natural selection. That they appeared in the appendix to a work on Naval Timber and Arboriculture. I can do no more than offer my apologies to Mr Matthew for my entire ignorance of his publication. If another edition of my work is called for, I will insert to the forgoing effect.*"

Here then, we have Darwin admitting that he was beaten to the theory of natural selection by Patrick Matthew, a fact which he emphasized in later editions of the *Origin of Species*.

What about Alfred Russel Wallace, the man generally viewed as the co-discoverer of natural selection; what did he think about Matthew's contribution? In a letter to Samuel Butler (published in Wallace's autobiography, *My Life*), who had emphasized the fact that Matthew beat Darwin to natural selection, Wallace states: "*To my mind your quotations from Mr Patrick Matthew are the most remarkable things in your book, because they appear to have completely anticipated the main ideas both of the* ***Origin of Species*** *and of* ***Life and Habits***."

Why then did Matthew not do more to extend and make known his idea, which he referred to as the "*natural process of selection*"? It seems that like Darwin, Matthew was loathed to publish his views because he was afraid of adverse public opinion and the ravages of the press. In an article published in the *Farmer's Magazine* of 1862, and referring to himself in the third person, he explains his fears: "*He (the author) was so far of this opinion that he did not speak of these original ideas till driven to do so in protecting them as his*."

Some years later, Darwin learned that Patrick Matthew had himself been beaten to the idea of natural selection by the American Empire Loyalist, William Charles Wells, and some recent research gives priority on the idea to James Hutton. Wherever priority on natural selection lies, it obviously does not lie with Darwin. Patrick Matthew was clearly well ahead of his time in his thinking on transmutation, or evolution, especially considering he believed in the importance of limited catastrophes, such as the supposed asteroid–induced extinction of the dinosaurs, as agents of evolutionary change.

Patrick Matthew and germ theory

In an attempt to marginalize Patrick Matthew, Darwinists have over the years, tried to claim that he failed to understand the significance of his idea on natural selection (a ludicrous idea recently again aired by Richard Dawkins in a book edited by Bill Bryson); a lowly fruit farmer, whose scientific mind could not possibly compare with that of great naturalists like Darwin and Wallace. But such attacks on Matthew are clearly misplaced since, not only did he beat Darwin and Wallace to natural selection, he also beat Pasteur to the germ theory!

By 1860 it was widely believed that disease in humans and animals were caused by poisonous air, or miasma. This, despite the fact that the notable Scottish surgeon, Sir John Goodsir, had actually isolated a microbe from the stomach of a patient suffering from gastroenteritis and had gone on to show that, by eradicating the germ with sodium hypochlorite, he could affect a cure. The so-called "*animalcular theory of disease*" had in fact been simmering under the surface since the late 1700s; reference to the word animalcular meaning any microscopic organism, including bacteria, fungi and protozoa. By the early 1860s when Patrick Matthew published his ideas on animalcular disease this work had been neglected, with the result that Pasteur's studies which began around the time, are usually, and wrongly taken as the point of origin of the germ theory. But in many ways Patrick Matthew was ahead of Pasteur as is shown by the following quote from 1861:

"*It is rational to suppose that the animalcule destroyers will be guided by instinct to attack and succeed better at it, when the attractions of life in the organism they attack are naturally weak, or weakened by something injurious. In the case of poison of instantaneous action, such as the bite of the serpent, we can hardly suppose the virus to be vital (animalcular). In that again of the mad dog, where the virus or infection has been known to lurk for a year before coming into perceptible action, we must rather suppose it vital, not chemical, and that the virus has remained this length of time dormant in the egg or germ. It is difficult to believe that it could remain so long inactive, being merely chemical. Hydrophobia however, seems, like small pox, measles etc. to require no previous weakness, as disposing cause. In the contagious diseases which affect only the skin, the vital nature is quite evident: the parasitic organism is generally of a size easily cognizable, and sequent to weakness. It is much more difficult to estimate the nature of the infectious diseases which pervade the body. To which of the above, chemical, or vital, the potato blight belongs is not easy to determine*."

The term virus was used at this time to mean poison, but it is clear that Matthew distinguished between living poison, that is animalcules, or germs, and the dead poison represented by snake venom. In this and other utterances on the germ, Matthew places great weight on the view that animalcule like to attack weakened bodies, but as can be seen from the next quotes, he recognizes that healthy people can also be infected:

"*Although certain kinds of animalcule destroyers (termed infectious disease) which feed upon superior organism sometimes attack the healthy, yet this is rather the exception to the rule. In most cases there is a preparatory weakness or want of health; or when the healthy*

are attacked, their vital stamina is generally sufficient to overcome the invading foe". Also:

"*I need not point out that starved lean cattle, etc, are very subject to animal diseases of the skin, and that in most cases disposing causes affecting health or state of fluids precedes infectious disease in man*".

Matthew then makes mention of his work done 30 years earlier, by combining his novel views on the role of animalcules in disease with his earlier utterances on natural selection:

"*Indeed, these destroyers form a portion of the scheme of nature, calculated to keep (at least that keeps) organic life in the highest possible health and strength and in accommodation to circumstances sweeping away all defections from the highest perfection. The operation of this law is especially marked as well in vegetable life as in animal.*"

Matthew's germ theory in relation to plants and trees

It is a largely unknown fact that Charles Darwin took a keen interest in microbes, particularly interested in the latest research of the cause of the potato blight. He would doubtless have been very interested in Patrick Matthew's publications on this subject in which he extends his ideas on the animalcular germ theory to infections in animals and humans. Matthew wrote a small number of essays on the potato blight in which he states that, in contrast to animals, overfed potato plants give rise to seed potatoes which are susceptible to rot and blight, and that, by drying the seed potato, these problems can be reduced:

"*Both soil and atmosphere are thus calculated to give a surfeit of food to the plant, and in a weakened state of the vis vistae induced by the formation of seed tubers and the loosening electricity, putrid disease takes place, and it becomes a prey to animalcule destroyers waiting the opportunity.*"

The reference here to "developed electricity" relates to static electricity which was in vogue at the time and was thought to play a role in the development of animal and plant disease; Matthew appropriates this idea and combines it with his animalcular theory of disease. He also recommends that by allowing the seed potato to green and dry before planting they become immune to rot, and later, blight:

"*This exposure and greening greatly increases the vital stamina, preserving the seed (i.e. potato) from the dry rot and the future plant from the potato blight and the rot in sheep are completely similar, excess moisture in the food, atmosphere. etc. disposing both to disease; the induced disease in both takes a vital character, is organic or animalcular and both we believe, are promoted by developed electricity.*"

Since Patrick Matthew's main interest was arboriculture it is not surprising that he applied his animalcular theory of disease to trees. Referring to the rot of larch trees in his book on Naval Timber he says:

"*The mature timbers of the larch, in some cases, remains a considerable time stained before the rot proceeds rapidly; in other cases the rot makes quick progress; in this rapid decomposition certain fungi assist greatly. When once seated, they seem to form a putrid atmosphere or tainted circle around them, enter by their living exhalations or corrupt emanation which is poisonous to the less vital parts of superior life, and also expedites the commencement of decay in sound dead organic matter, such as timber, thus furthering the decomposition so far as to render it suitably formed for their foul appetites and paving the way to their further progress.*"

Finally, he seems to notice the formation of what appear to be ectomycorrhizae when he states:

"*In dry soils, there is sometimes an accumulation of whitish substance within the ground, around the roots of trees, which some refer to as excrementitious deposits, but which, we think, is rather the produce of some subterranean vegetable fungus or mould*".

Patrick Matthew, the man who came up with the idea of natural selection before Darwin and who commented on the germ theory before Pasteur was more than a naturalist. Like Alfred Russel Wallace, he championed the working man (notably farm labourers), and in his book *Emigration Fields* encouraged them to emigrate to America and what would become the Dominions. Matthew was also a business man, who owned boats which traded from Dundee to the Baltic. He even opposed the building of the Tay Bridge, suggesting that the proposed site was unsafe (he was proven right when, after his death, the bridge was destroyed in a storm), suggesting that the money required to build it would be better spent building homes for the poor of Dundee. Matthew died in 1874, a considerable thinker who was never recognized as such in his lifetime and has been neglected ever since; hopefully his time in the limelight has now belatedly begun.

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further reading

Matthew's seminal work can be read via Google Books:

■ Matthew, P. (1831). *Naval Timbers and Arboriculture.*

The following papers on potato blight by Matthew can again be accessed via Google Books:

■ Matthew, P. (1861). The potato blight and harvest prospects for the North, *British Farmer's Journal*, **20**, pp99-101.

■ Matthew, P. (1861). The potato, *Farmer's Journal* **20**, pp196-197.

An excellent, detailed review of Matthew's work (without the reference to germ theory) is given in:

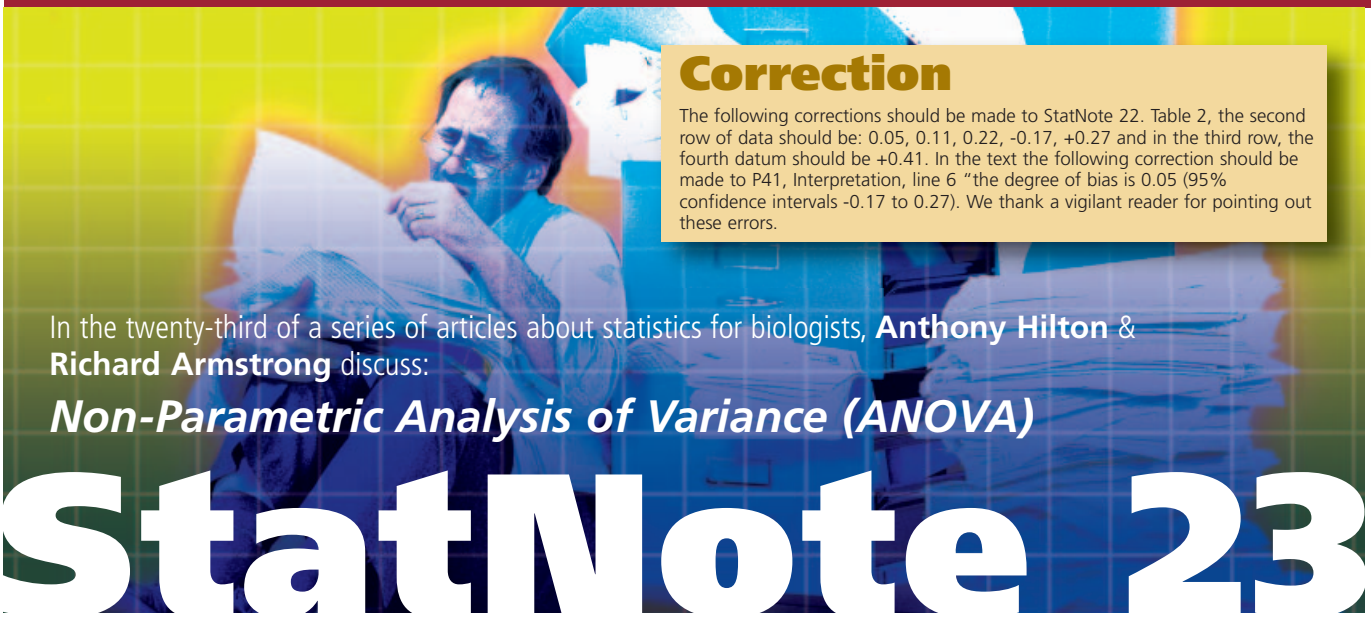
■ Dempster, W.J. (1996). *Evolutionary Concepts in the Nineteenth Century, Natural Selection and Patrick Matthew*, Edinburgh, Pentland Press.

Unusual aspects of the history of the germ theory and details of Darwin's interest in microbes, together with Patrick Matthew's ideas on natural selection can be found in the following:

■ Wainwright, M. (2003). An alternative view of the early history of microbiology. *Advances in Applied Microbiology*, **Vol. 52**, pp33-36.

■ Wainwright, M. (2008). It's not Darwin's or Wallace's theory. *Saudi Journal of Biological Sciences* **Vol. 15**, pp1-8.

■ Wainwright, M. (2009). Charles Darwin and microbes *Microbiologist*, **Vol. 10.** No.2, pp32-35.



Correction

The following corrections should be made to StatNote 22. Table 2, the second row of data should be: 0.05, 0.11, 0.22, -0.17, +0.27 and in the third row, the fourth datum should be +0.41. In the text the following correction should be made to P41, Interpretation, line 6 "the degree of bias is 0.05 (95% confidence intervals -0.17 to 0.27). We thank a vigilant reader for pointing out these errors.

In the twenty-third of a series of articles about statistics for biologists, **Anthony Hilton** & **Richard Armstrong** discuss:

Non-Parametric Analysis of Variance (ANOVA)

StatNote 23

In previous StatNote articles (Hilton & Armstrong, 2007a, 2007b, 2007c, 2008a, 2008b), different types of analysis of variance (ANOVA) were described and each was applied to a specific experimental design. To carry out an ANOVA, however, several assumptions are made about the nature of the experimental data which have to be at least approximately true for the tests to be valid. One of the most important of these assumptions is that a measured quantity must be a parametric variable, i.e. a member of a normally distributed population. If the data are not normally distributed, then one method of approach is to transform the data to a different scale so that the new variable is more likely to be normally distributed (Hilton & Armstrong, 2006). An alternative method, however, is to use a non-parametric ANOVA. There are a limited number of such tests available but two useful tests will be described in this StatNote, *viz.*, the Kruskal-Wallis and Friedman's ANOVA.

Scenario

A soil microbiologist wished to determine the number of strictly anaerobic bacteria as a percentage of the total bacterial population present within the different horizons of a soil. Two experiments were envisaged employing two different experimental designs. In the first experiment, five random samples of 1g of soil were collected into a sterile universal bottle from each of five different soil horizons labelled from the soil surface downwards, according to the standard method for soil profiles, A1 to C. On return to the laboratory, each 1g sample was suspended in 2ml sterile distilled water (SDW) and thoroughly vortex mixed to release bacteria from the soil matrix. Serial dilutions of the soil sample were prepared and 0.1ml volumes of each dilution inoculated onto the surface of neomycin fastidious anaerobe agar and nutrient agar plates. The inoculated plates were incubated under anaerobic and aerobic conditions respectively for 24 to 48 hours following which time the plates were observed for colony growth. The sample was corrected for sample volume and dilution and the cfu g^{-1} soil calculated. The number of colonies growing anaerobically was then expressed as a percentage of the total number of bacteria recovered from each soil horizon.

In the second experiment, a different sampling strategy was employed and a single 1g sample of soil was collected from each of the five soil horizons on five separate days. The recovered soil samples were processed in the laboratory as described above. In both experiments, the objective was to determine whether there was a significant difference between the different soil horizons in the number of anaerobic bacteria as a proportion of the total bacterial population.

The Kruskal-Wallis test (for three or more 'independent' samples)

Data

The data from the first experiment comprise the number of anaerobic bacteria, as a percentage of the total bacteria, present within five random samples taken from each of the five soil horizons and are presented in Table 1. The data therefore comprise a 'single classification in a randomized design' (Armstrong & Hilton, 2004). Because the data are percentages, and most of the figures are less than 10%, it is likely that the data are not normally distributed. One possible method of analysis is to transform the data to an angular (arcsin) scale (see StatNote 4) and carry out the usual one-way ANOVA (Armstrong & Hilton, 2004), but an alternative approach is to carry out a non-parametric analysis of the percentage data.

How is the analysis carried out?

The Kruskal-Wallis test is the non-parametric equivalent of the one-way ANOVA in a randomized design (Armstrong & Hilton, 2004) and essentially tests whether the 'medians' of three or more independent groups are significantly different (Kruskal & Wallis, 1952). To carry out the test, ranks are assigned to the whole data, regardless of group, as for the Mann-Whitney test (Hilton & Armstrong, 2006), amending the ranks within each tied run to the mean of the ranks within the run (Dawkins, 1975). The ranks in each column are then summed and the total squared; the result then being used to calculate the Kruskal-Wallis statistic H'. H' is referred to a table of the H' statistic to obtain a 'P' value. When there are more than three treatments or five replicates per treatment, however, H' can be referred to the table of the χ^2 distribution (Dawkins, 1975). Most statistical packages will carry out this type of analysis as part of their non-parametric statistics option.

Interpretation

In the present example, H' = 22.416 which is significant at the 0.1% level of probability ($P < 0.001$) suggesting there are highly significant differences between the medians of the five groups. More specific hypotheses regarding differences between pairs of medians could then be tested using the Mann-Whitney test as a *post hoc* procedure (Hilton & Armstrong, 2006). The data clearly show, however, that the proportion of organisms capable of growing under reduced oxygen supply increases with depth down to the horizon depth B1 but then declines below this level.

Table 1. The Kruskal-Wallis test (non-parametric test for three or more 'independent' groups). Data are the number of anaerobic bacteria as a percentage of the total found in five replicate samples taken within five soil horizons

Depth of soil horizon				
A1	***A2***	***B1***	***B2***	***C***
2.0	0.6	6.3	2.0	0
1.5	0.7	6.5	2.2	0.01
2.1	0.5	6.0	1.9	0.2
1.0	0.7	6.2	2.3	0
2.0	0.6	6.1	2.2	0.01

1. Assign ranks to whole data set, ties getting mean of ranks within a run.
2. Sum the ranks for each column R, calculate the square of the totals R^2 and divide R^2 by the number of observations in each column (R^2/n).
3. Add up the values of R^2/n from each column to give $K = \Sigma R^2/N$.
4. Calculate $H' = [12K/N(N + 1)] – 3(N + 1)$ where N = total number of observations (N = 25).
5. H' = 22.42 and refer to table of H' statistic. In this case $P < 0.001$.
6. If more than 3 treatments or 5 replicates per treatment refer H' to table of χ^2 with DF one less than the number of treatments.

Friedman's test (for three or more 'dependent' samples)

Data

The data from the second experiment comprise the number of anaerobic bacteria as a percentage of the total in a single sample taken within each of the five soil horizons but samples were collected on five separate days and are presented in Table 2. The data therefore comprise a 'two-way classification in a randomized blocks design', with sample day comprising the 'block' and the appropriate analysis is the non-parametric equivalent of the two-way ANOVA described in StatNote 10 (Hilton & Armstrong, 2007b).

How is the test analysis carried out?

As for the Kruskal-Wallis test, Friedman's test compares the medians of three or more dependent groups (Friedman, 1937). The scores are ranked individually for each day with tied values given the mean of the ranks as usual. The ranks are summed for each soil horizon and the square of the sum of ranks calculated. The statistic 'S' is then obtained as shown in Table 2 and referred to a table of Friedman's 'S' or, if not available, χ^2 is calculated as shown and taken to the χ^2 table for K – 1 DF, where K = the number of treatments, to obtain a 'P' value.

Table 2. Friedman's test (non-parametric test for three or more 'dependent' groups). Data are the number of anaerobic bacteria as a percentage of the total found within five soil horizons collected on five separate days

	Depth of soil horizon				
Day	***A1***	***A2***	***B1***	***B2***	***C***
3.0	3.0	0.8	7.5	2.5	0.03
2.5	2.5	0.7	7.2	2.4	0.01
2.0	2.0	0.6	6.3	2.0	0
1.5	1.5	0.5	6.0	2.2	0.01
1.0	1.0	0.5	6.2	1.9	0
Sum of ranks	**17.5**	**10.0**	**25.0**	**17.5**	**5.0**

1. Rank scores for each day separately; ties getting the mean of ranks within the tie.
2. Calculate the sum of ranks $\Sigma(R)$ for each column and $\Sigma(R^2)$.
3. K = Number of treatments.
4. Calculate $S = \Sigma(R^2) – \Sigma(R^2)/K$ and refer to table of Friedman's 'S'.
5. If table of 'S' is not available calculate $c2 = 6S/ R = 19.19$ ($P < 0.001$).
6. Refer to table of χ^2 with K – 1 DF.

Interpretation

In the present example $\chi^2 = 19.19$ which is significant at the 0.1% level of probability ($P < 0.001$) indicating a significant effect of soil horizon on percentage of anaerobic bacteria. Examination of the data also suggests there may be some differences between samples collected on the different days with slightly higher percentages of anaerobic bacteria recorded on the first two days.

Conclusion

There are a limited number of non-parametric tests available for comparing three or more different groups. Two useful non-parametric tests are the Kruskal-Wallis and Friedman's tests. The Kruskal-Wallis test is the non-parametric equivalent of the one-way ANOVA (Armstrong & Hilton, 2004) and essentially tests whether the medians of three or more independent groups are significantly different. Friedman's test compares the medians of three or more dependent groups and is the non-parametric equivalent of the two-way ANOVA (Hilton & Armstrong, 2007b).

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- Kruskal, W. and Wallis, W.A. (1952) Use of ranks in one-criterion variance analysis. *J Am Stat Assoc* **Vol. 47**, pp583-621.


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Completing a PhD — academia and beyond

Continuing the theme of the last PECS article on PhD experiences, **Jo Heaton** discusses her experiences completing a PhD based within a University

In the loop pecs

News from the S*f*AM Postgraduate and Early Career Scientist Committee

Thinking back I realize that I sort of fell into my PhD with no clear idea of what was expected of me and no plans of what I would get out of it, other than following my love of microbiology for another few years. I'd recently graduated with a BSc in Biological Sciences from Lancaster University, after completing my final year project in Keith Jones' laboratory and had started a job as a pest-control technician (read '*rat-catcher*') with a major firm. Keith and I had kept in touch and as I realized that the job was not all it promised, I emailed to ask if there was any chance of him helping me find a microbiological role elsewhere. Amazingly, he replied that he had a PhD position available and obviously, I applied.

My PhD was part of an EU Framework 6 project, WaterWeb, which aimed to establish the risks associated with the use of lower-quality water in irrigation. There were several facets to this project and the consortium included academics in Sweden and the Western Balkans, giving my research an international flavour. Very early on in my first year, we hosted a number of visiting scientists from Serbia, and I enjoyed feeling that my research was contributing to such a major team effort.

Keith was always on the look-out for new opportunities, and he successfully secured a grant to enable us to complete some of the field research in Ghana, West Africa. I spent a few weeks in Kumasi, gaining a real feel for 'bucket and spade' microbiology, and halting all teaching in the department as all the glass Petri dishes were in use for my experiments!

The project really gained momentum after our work in Ghana, and focussed on the phyllosphere, rather than just irrigation water. We collaborated with researchers at the Institute of Food Research and I became interested in the genetic aspects of survival on the leaf, and the interactions with epiphytic bacteria. This, coupled with a building refurbishment, meant that I moved into a new, larger lab, and joined the Plant Ecophysiology group. This was a bit of a culture shock: I had been spoilt with a lab, two autoclaves and several incubators to myself and now found myself in a rowdy laboratory with over twenty students and postdocs and even dedicated technicians.

I think it was at this point that I really began to appreciate what it meant to be part of an academic research group, with constant collaboration and new ideas popping up, the opportunity to develop new skills through observation and an eye on external funding, commercial relevance and publications. I received some additional funding from the Horticultural Development Council to complete some field trials looking at the microbial quality of salad vegetables grown in polytunnels and this formed the majority of my thesis, with plenty of work looking at the effect of biologically-relevant UV and the potential benefits of using spectral plastics — a long way from the initial project brief. I presented my research regularly at a growers' consortium and discussed my results with industry representatives from Bakkavor and Vitacress, amongst others, benefiting from their insights and expertise. Working at the interface of academic research and industrial application allowed me to develop my communication skills and understand the need for effective public engagement in research. This is the role I work in today.

My PhD demonstrated the changing nature of research and how experimental results can lead to new avenues of investigation, but moreover it brought home to me the importance of networking and the benefits of collaboration. I don't work at the bench now, rather it is the other skills developed during my PhD — enterprise, communication, grant writing, project management — that I have made use of in my current career.

Dr Joanna Heaton
Public Engagement Manager
University of Central Lancashire

Congratulations!

Congratulations go to **George Aboagye** the former Chair of PECS who was awarded his PhD recently. Also to **Matthew Stokes**, a recent addition to PECS, for winning second prize in the postgraduate seminar day at Kingston University for his talk entitled "Molecular characterization of bla_{CTX-M} plasmids from veterinary and human *E. coli* isolates".

If you know of a PECS member who deserves recognition for an accomplishment please contact Phillip at pecs@sfam.org.uk

Phillip Humphryes
PECS Communications Officer

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Creating more representative models of the oral microbial community

Over my summer vacation, I spent 10 weeks working with the Pharmaceutical Microbiology research group in the School of Pharmacy at the University of Manchester. The group has a strong interest in biofilms, and one of their key areas of research is looking towards creating more representative models of the oral microbial community. The project that I undertook during my time in the laboratory focussed on the "Marsh" consortium: 10 bacteria which together serve as a simplified model of the oral microbiota. This consortium includes cariogenic bacteria such as *Streptococcus mutans*, periodontopathogens such as *Porphyromonas gingivalis* and commensal species such as *Veillonella dispar* and *Actinomyces naeslundii*.

Since dental caries and periodontitis have a microbial aetiology, it is logical that the prevention of these diseases is attempted through the control of dental plaque. Anti-plaque agents are therefore required in order to control or prevent plaque formation as adjuncts to effective oral hygiene. The aim of this project was to investigate the potency and ecological effects of two potentially synergistic antimicrobial agents, singly and in combination and also after formulation into toothpaste.

Inocula for microtitre plate determination of bacterial antimicrobial susceptibility were prepared as follows: single colonies of test bacteria were inoculated into sterile, anaerobic half strength thioglycolate broth (10ml) within sterile plastic universals. Stock solutions of toothpastes (33%) and antimicrobials (5.0mg/ml) were prepared in distilled water. Toothpaste slurries were centrifuged (13000 x g) for 10min until a clarified supernatant was obtained. The antimicrobials were sterilized by filtration through single cellulose acetate filters (0.22μm pore size). Testing was performed in 96-well microtitre plates. Diluted overnight culture (100μl) was delivered to each test well. Antimicrobial solution (100μl) was added to the first column of test organism and mixed. Doubling dilutions were then carried out across the plate using a multi-channel pipette, changing the tips at each dilution step. The plates were then incubated for 48 hours in either an anaerobic or standard incubator at 37^{o}C. Minimum inhibitory concentrations (MICs) were expressed as the lowest concentration of antimicrobial at which growth did not occur. Each MIC determination was carried out in triplicate (in the same 96-well plate). Negative controls were performed with only sterile broth in each well and positive controls were performed with only overnight culture in the wells.

After MIC testing of all 10 bacteria, minimum bactericidal concentration (MBC) testing was carried out using the microtitre plates set up for the MIC determinations. Aliquots (10μl) taken from each well up to and including the MIC endpoint were transferred and spot-plated onto the appropriate agar and incubated overnight. MBCs were expressed as the lowest concentration of biocide at which growth was not observed after five days of incubation.

MIC values obtained for the two antimicrobials tested for each of the 10 test bacteria were then used to design checkerboard synergy experiments. Diluted overnight culture (75μl) was delivered to each well as before. One agent was delivered horizontally across the microtitre plate at concentrations ranging from half the MIC to the MIC. Similarly, the other antimicrobial was delivered vertically down the plate at concentrations ranging from half the MIC to the MIC.

V. dispar was most susceptible to the test compounds. Generally, MBCs were found to be twice the MIC of toothpaste or antimicrobial, apart from *S. mutans* for which the MBC of toothpaste was 8 to 16 times the MIC. Synergy was observed most markedly with *V. dispar*, where growth was reduced by significantly lower concentrations of antimicrobial agent together than each alone. In contrast, growth of *S. sanguis* was noted in every well of that microtitre plate, including those containing the highest concentrations of solution.

The findings of the synergy experiment, in particular, offer the possibility of further work. It would be beneficial to quantify the synergistic relationship between the two agents tested, pinpointing which groups of bacteria are most sensitive to this pairing of compounds, to what degree and why.

As an undergraduate in the School of Pharmacy, I enjoyed the Microbiology modules in the earlier years of my course, and I am sure my experiences over the summer will help me to put what I learned into context throughout both my third and final years. My IT skills, data handling and analysis have improved greatly, I am now confident and competent in aseptic technique — a skill I know will be invaluable in the clinical environment when I qualify as a pharmacist. I now appreciate much more the preparation and planning involved when conducting a research project, and after being part of a research group I am positive I want to undertake further study after graduation: a decision I would not have

been able to make, had I not been given the chance to do this placement.

I would like to thank Dr Ruth Ledder for her patient support and good humour, Dr Andrew McBain and Professor Peter Gilbert for their guidance, the rest of the Pharmaceutical Microbiology group for their help and, very importantly, S*f*AM for giving me this opportunity.

Elizabeth Aubrey

Optimizing Antibiotic Therapy

Bacterial persistence was first observed in 1944 by Bigger in staphylococci exposed to penicillin. Bigger identified a small fraction of cells (1 in 10^6) that remained fully viable even after prolonged incubation (Bigger, 1944). Such cells are not classified as mutants, as they and their resulting progeny are still susceptible to the antimicrobial activity of penicillin (Lewis, 2000). Although the nature of persistence is unknown it has been suggested that such cells are unable to initiate or undergo programmed cell death. As such these cells are proposed to be in a dormant state and are subsequently responsible for the survival and proliferation of the microbe (Balaban *et al.*, 2004, Lewis, 2000).

In order to eliminate persister cells this project utilized theoretical tools from applied mathematics and computer science. An optimized medication dosage strategy which takes into account bacterial persistence was found to follow a novel time profile. This strategy, though marginally more complicated than standard dosage strategies, takes into account bacterial persistence. In order to yield data to support this theoretical model the response of *E. coli* and *S. aureus* to ampicillin was studied. This work was in collaboration with Dr Ole Steuernagel and Dr Daniel Polani of the University of Hertfordshire.

Initial experiments identified the antibiotic susceptibility profile of both organisms, followed by determination of the minimum inhibitory and minimum bactericidal concentrations of ampicillin. Cultures were grown on nutrient agar at 37°C and all experiments were performed in triplicate. The Miles-Misra technique was used for viable counting of bacterial cells to generate data for growth and death curves. This technique provided both economical and speed advantages. The effect of antibiotic exposure on the microbe was assessed by total and viable counting, with samples taken pre– and post–antibiotic exposure. Following exposure the culture was centrifuged and the pellet re-suspended in sterile nutrient broth, thereby mimicking the clearance of the antibiotic from the human system. The culture was subsequently allowed to recover for 24 hours and samples taken. Antibiotic exposure, centrifugation and re-suspension were once again conducted.

By undertaking this S*f*AM students into work experience I was able to enhance my laboratory skills and research experience and to work and interact with a range of people, signifying the importance of collaboration in science. The opportunity provided by S*f*AM and Dr Tim Aldsworth will prove invaluable in my future career progression. For this I would like to thank S*f*AM, Dr Tim Aldsworth, Dr Ole Steuernagel and Dr Daniel Polani. The experience gained has given me the confidence to pursue a PhD.

Harsha Siani

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Do the commensal microbiota of the GI tract play a role in onset or progression of diabetes?

The lumen of the mammalian gastrointestinal (GI) tract harbours a rich and diverse microbial community that is essential for healthy development and wellbeing of the host. In recent years our understanding of the significance of our gastrointestinal microorganisms (now more commonly referred to as the commensal microbiota) in maintaining healthy gut function has increased considerably. We now realize that they play a very important role, not only in the metabolism of food we digest but also in immunity, intestinal motility and healthy development of the GI tract. The 'beneficial' qualities of certain genera, such as *Lactobacillus* and *Bifidobacteria*, have long been exploited. However, research into the structure and function of commensal microbial communities has only recently begun to yield an understanding of the complex mechanisms by which they

exert influence on mammalian physiology and the significance of such interactions on health and wellbeing.

The commensal microbial community of the GI tract begins to develop shortly after birth and the mature bacterial community of the human adult is estimated to reach levels of 10^{12} to 10^{14} microbial cells, comprised of more than 500 species (Hooper, 2004). We now know that, among other important functions, these organisms are essential for the structural maturation of the intestinal villi (Hooper & Gordon, 2001), development and maintenance of gut sensory and motility functions (Barbera *et al*, 2005), and modulation of the immune system (reviewed by Walker & Buckley, 2006).

The major role of these microorganisms is the anaerobic digestion of carbohydrate and protein. Microbial fermentation of otherwise indigestible dietary carbohydrates and fibre yields assimilable metabolites such as short chain fatty acids (SCFA) including acetate, propionate and butyrate. These are absorbed by the colonic enterocytes (which use them as an energy source) and then transported to the liver and peripheral tissues. This is an important first step in the release of assimilable dietary substrates to the rest of the body — if it is altered or impaired how does this affect subsequent biochemical pathways in the body's tissues? It is speculated that the commensal gut microbiota may be implicated in many more aspects of non-infectious human diseases than previously expected (Nicholson *et al*., 2005). Attention is now turning towards the role that the commensal microbiota of the GI tract may play in the induction of diabetes and pathophysiology of the diabetic GI tract.

It is acknowledged that Type 1 diabetes has genetic and environmental triggers, including a suspected viral aetiology. However, could the commensal microbiota of the GI tract play a role in induction of diabetes? August and September 2006 saw the publication of the first original studies investigating functional associations between the prokaryotic community of the GI tract microbiota and diabetes. Dumas *et al*., (2006) reported evidence, in the Proceedings of the National Academy of Sciences (PNAS), for impaired glucose homeostasis in insulin resistant mice, resulting from GI microbial interference in choline metabolism. Brugman *et al*., (2006) revealed their observation of higher populations of the microbial genus *Bacteroides* in those diabetes-prone rats that eventually went on to develop Type 1 diabetes, long before clinical onset was observed. Their study also demonstrated that development of diabetes could be retarded by antibiotics.

We are currently interested in whether there are changes in the GI microbiota following diabetes and whether they play a role in the progression of diabetes and subsequent GI pathophysiology. GI dysfunction is common in patients with insulin dependent or non-insulin dependent diabetes. While symptoms such as faecal incontinence, constipation, diarrhoea and abdominal pain are not necessarily life-threatening, they cause significant decrease in quality of life. The pathogenesis of diabetic GI dysfunction is extremely complex and probably multifactorial. However, it is currently thought that GI dysfunction is mostly due to the 'generalized' effects that diabetes has on the nervous system resulting from neuropathy. Poor transit may occur in any region in the gut and in all stages of diabetes (Horowitz & Fraser, 1994). Abnormal transit of material in the GI tract, resulting in delayed or rapid emptying of stomach, small intestine and colon appears to be related to impaired muscle contraction and neuropathy. We have been characterizing the microbiology of the diabetic GI tract and presented a poster at the S*f*AM 2007 Summer Conference demonstrating our initial findings on the differences between healthy and diabetic GI microbiota.

We are now investigating the effect that SCFA and other bacterial metabolites have on GI motility and were very grateful for a grant from the President's Fund which allowed us to present our work on the effect of microbial SCFA and lactate on serotonin receptor expression in the GI tract at the 6th INRA-RRI Joint symposium, Gut Microbiome: Functionality, interaction with the host and impact on the environment, held in Clermont-Ferrand, France. As yet, there is little research on the role of the commensal microbiota in GI motility. The mammalian GI tract has an extremely complex system of innervation which responds to many sources of stimuli but despite the abundance of bacterial cells, scant attention has been paid to 'neurosignalling' from the prokaryotic colonizers of the GI tract (Barbera *et al*., 2005, Nicholson *et al*., 2005). Our cross disciplinary work will therefore really benefit from the opportunity afforded us to present our work and network with other GI researchers.

There is still a long way to go in understanding whether antibacterial strategies could improve GI function and quality of life in diabetic patients. However, it is likely that along the way we will continue to discover ways in which the GI bacterial community, not just individual infectious pathogens, contribute to disease.

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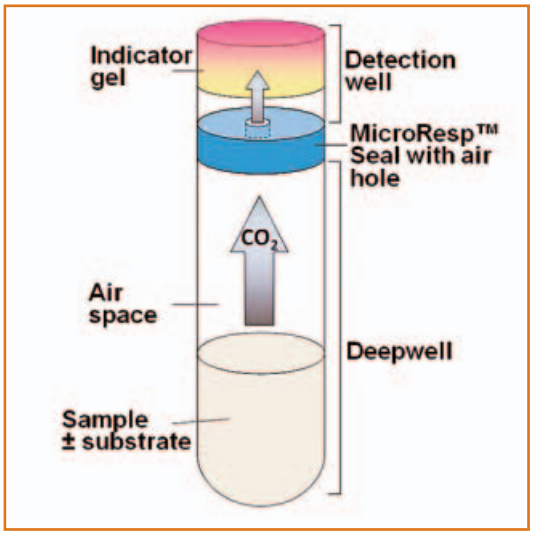

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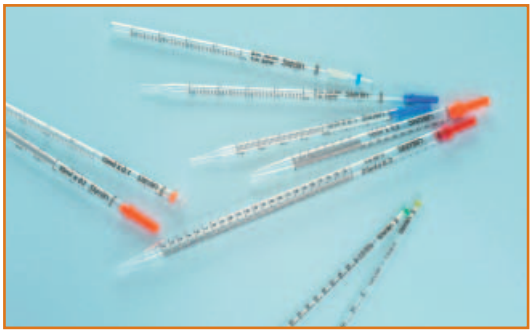

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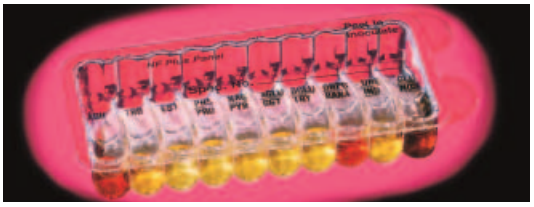

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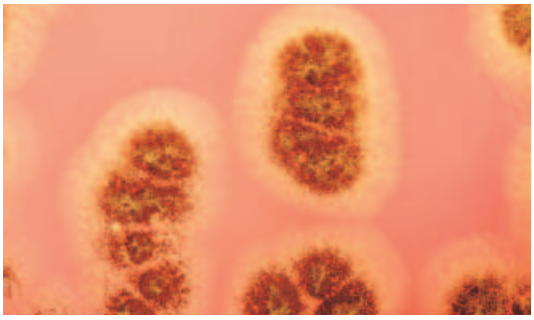

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Dichloran Rose Bengal Chloramphenicol Agar (ISO) (DRBC Agar) is for the enumeration of viable yeasts and moulds in products with a water activity above 0.95. It is prepared according to ISO 21527-1:2008 and complies with Bacteriological Analytical Manual (BAM) and American Public Health Association (APHA) methods. The incorporation of Rose Bengal helps limit colony size and is selective against bacteria.

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