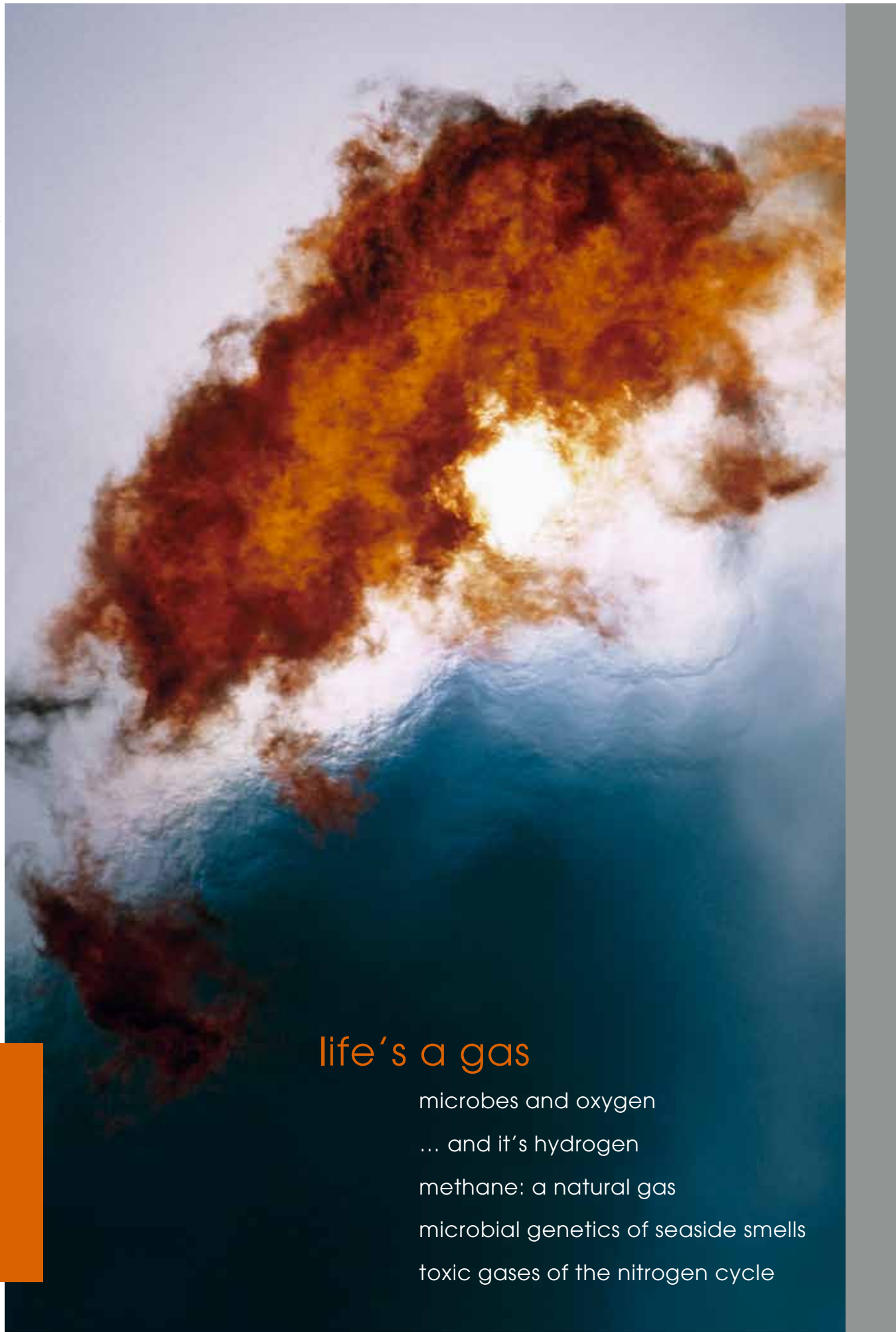
microbiologytoday

vol35 | aug08
quarterly
magazine of
the society
for general
microbiology



life's a gas

microbes and oxygen

… and it's hydrogen

methane: a natural gas

microbial genetics of seaside smells

toxic gases of the nitrogen cycle

contents

vol35(3)

regular features

other items

articles

Cover image A natural-gas fireball. *Photos.com / Jupiter Images*

Editor Dr Matt Hutchings Editorial Board Dr Sue Assinder, Dr Paul Hoskisson, Professor Bert Rima Managing Editor Janet Hurst Assistant Editors Lucy Goodchild & Faye Stokes Editorial Assistant Yvonne Taylor Design & Production Ian Atherton Contributions are always welcome and should be addressed to the Editor c/o SGM HQ, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG Tel. 0118 988 1809 Fax 0118 988 5656 email mtoday@sgm.ac.uk web www.sgm.ac.uk

Advertising David Lancaster, Ten Alps Publishing, London Office, 10 Savoy Street, London WC2E 7HR t 0207 878 2316 f 0207 379 7118 e david.lancaster@tenalpspublishing.co.uk

Regular feature images pp. 107 *SGM*; 137, 139, 155 *Comstock / Jupiter Images*; 143, 147 *Stockbyte*; 145 *Digital Vision / Getty*; 151 *Ablestock / Jupiter Images*

ISSN 1464-0570 Printed by Latimer Trend & Company Ltd, Plymouth, UK

SGM Council and sub-committees – changes proposed

News items in previous issues of *Microbiology Today* have mentioned that a small working party of Council members and staff has been considering the optimum size and structure of Council and its various sub-committees, to ensure continuing and effective good governance of the Society, and reflect best modern practice. Council members are trustees of SGM as a charity and directors of the company limited by guarantee. As such they have responsibility to ensure compliance with relevant legislation, and to ensure effective management of the Society in achieving its charitable objectives. They also have wider responsibilities to the members of the Society, and for the promotion of all aspects of microbiological science in the fields of education, research and public and political awareness. The working party is chaired by Petra Oyston and its members are Robin Weiss, Charles Penn, Neil Gow and Bert Rima, with Ron Fraser and Janet Hurst from SGM headquarters in attendance.

The working party has held several meetings since June 2007, and has surveyed current governance arrangements in similar organizations. The Society's solicitors have also been consulted on the implications of any proposed changes for company and charity law, and for the mechanism for implementation of any proposed changes through re-wording of the Society's governing documents.

An early conclusion of the working party was that at 24 members – 12 Officers with specific job titles and 12 Elected Members – SGM Council had grown over the years to a much larger size than is consistent with best modern practice for an effective decision-making and governing body. The large number tended to make discussions protracted and decision-making more difficult. It was also felt that the functions of some of the officer posts had been increasingly overtaken by the employment of professional staff at the Society's headquarters, and that there were opportunities to re-define and consolidate duties. In addition, some of the Elected Members felt that they were not being asked to contribute enough in specific ways to Council, and that their range of responsibilities should be enhanced and more clearly defined.

The survey of similar bodies and of the literature on the theory and practice of governance and decision-making suggested that around 8–15 members was optimal. Some scientific learned societies have had recent experience of downsizing their governing bodies to within this range.

Accordingly, the working party and current Council are recommending a move towards a smaller Council, comprising the following appointed Officers: President, General Secretary, Treasurer, Education and Public Affairs Officer, Scientific Meetings Officer, and Publications Officer, together with six Elected Members. Council would also have the power to co-opt up to three additional members, to represent constituencies or areas of microbiological science that were thought not to be adequately represented in the existing membership. One safeguard would be to ensure that the Society's membership in Ireland is always adequately represented.

At present, the work of Council is expedited by three sub-committees: Treasurer's, Scientific Meetings, and Publications, and these will continue. Publications Committee will become the primary forum for the Editors-in-Chief of the Society's journals, and will be chaired by the new Publications Officer. In addition, an Education and Public Affairs Committee will be formed, chaired by the eponymous Officer.

A Special Resolution to modify the Society's Articles of Association will be put to the Annual General Meeting on 9 September, and is printed in the Annual Report and AGM booklet circulated with this issue of *Microbiology Today*. The proposed timetable is that the changes to the Officers and sub-committees will be effective from September 2009, and that the elected Members will reach their new 'steady state' number in September 2011.

SGM Council has over many years steered the Society in many successful directions, including a vibrant and developing programme of scientific meetings, taking on publication of two additional journals, and greatly increasing its activities in education and public awareness of microbiology. In all this time the Society has been efficiently managed and has remained financially robust. The proposed changes to a leaner and fitter Council with more focused responsibilities for individual members aim to build on this and continue to deliver the best service to the membership, the general public and microbiological science.

Petra Oyston and ***Robin Weiss***

New members of Council

The following have been elected unopposed to serve on Council for a period of 4 years from September 2008:

> **Professor Mark Harris**, Institute of Molecular and Cellular Biology, University of Leeds
>
> **Dr Gary Rowley**, School of Biological Sciences, University of East Anglia

Profiles of the new Council members will appear in a future issue of *Microbiology Today*.

Annual General Meeting 2008

The Annual General Meeting of the Society will be held on Tuesday, 9 September 2008 at the Society Meeting at Trinity College Dublin.

Agenda papers, including reports from Officers and Group Conveners, the Accounts of the Society for 2007 and a Special Resolution to amend the Articles of Association are circulated with this issue of *Microbiology Today*.

Virology at Warwick

Sincere apologies are due to the Department of Biological Sciences at the University of Warwick for implying in the May issue that the only available stand-alone virology degree courses in the UK are at Glasgow University. The notice published on behalf of the latter was accepted in good faith. An undergraduate degree in virology has, of course, been available at Warwick for many years. Details of the course may be found at: **www2.warwick.ac.uk/study/undergraduate/courses/depta2z/biology/c520/#virology**

SGM Council

February Meeting Highlights

SGM Meeting, Edinburgh, Spring 2008

The meeting took place in the Edinburgh International Conference Centre and was attended by 1,318 participants. The quality of the science and the organization were generally regarded as excellent. The SGM Prize Lectures enjoyed a particularly large audience.

Planning for future SGM meetings

The new meetings planning system has been approved by Council and will be fully implemented from Spring 2009 onwards.

European Society for Clinical Virology (ESCV)

SGM is now providing administrative support (membership registration, subscription renewal and accounting) for the ESCV.

Nominations for SGM Prizes 2009

Nominations for the Colworth, Fleming, Fred Griffiths and Peter Wildy prizes for 2009 are requested (see the May issue of *Microbiology Today* and the SGM website for details).

The SGM Medal

Council decided to create a new prize, called the SGM Medal. This prize will be bestowed annually on an individual from anywhere in the world whose research is of internationally high reputation and has been of significance reaching beyond microbiology. The Prize comprises a Medal, a cheque for £1,000 and covers travel, accommodation and subsistence. Council approved the rules (see SGM website), and it is intended to bestow the first medal in 2009. A sub-committee will prepare recommendations for the July Council meeting.

Review of Council composition and functions

Council received the recommendations of the working group, chaired by Professor Petra Oyston, that had been set up to review its structure and function. Wide-ranging discussions ensued on the responsibilities of Elected Members, the roles of SGM officers, and the optimum size of such a body. As described on p. 106, the group proposed reducing Council members to 6 Officers and 6 Elected Members. Much of the business would be done in sub-committees, the chairs of which would report to Council. During its sessions Council would concentrate on policy and strategic matters and on difficult/controversial issues. Council approved these proposals and a Special Resolution to authorise the changes to the Articles of Association will be put to the Annual General Meeting in September 2008.

SGM Finances

Council approved the financial statements for 2007.

Retiring member of Council

The President Robin Weiss thanked retiring member Professor Rick Randall for his valuable contributions to the activities of Council.

Ulrich Desselberger
General Secretary

People

Queen's Birthday Honours

Congratulations to **Professor Brian I. Duerden**, Professor of Medical Microbiology, Cardiff University School of Medicine, Inspector of Microbiology and Infection Control at the Department of Health and former Editor-in-Chief of *JMM*, on the award of a CBE for services to medicine and charity.

Power unseen

In August, **Bernard Dixon**'s *Power Unseen – How Microbes Rule the World* becomes available as a print-on-demand book. A collation of 75 vignettes about different micro-organisms and their activities, it was originally published by OUP, but has been out of print for several years. Now published by PFD, it can be obtained through **www.amazon.co.uk**

ASM award

Bernard Roizman, Distinguished Service Professor of Virology at the University of Chicago, has been presented with the Abbott–ASM Lifetime Achievement Award at the recent 108th ASM General Meeting in Boston, USA. Sponsored by Abbott Laboratories, this is ASM's premier award for sustained, remarkable contributions to the microbiological sciences. Professor Roizman is widely recognized as a leading authority in herpes simplex virus biology.

Floral tribute

Well done to **Tim Wreghitt**, former SGM Clinical Virology Group Convener and Honorary Consultant in Microbiology at Addenbrookes Hospital, Cambridge on yet again winning a gold medal at the RHS Chelsea Flower Show. He organized an exhibit on behalf of the Royal College of Pathologists and Health Protection Agency. The display featured 'malaria and treatment plants' in the Continuous Learning section of the Show.

Tim is to receive double honours this year, as he is also to be made an OBE in the Queen's Birthday Honours, for services to National Health virology service provision.

▲ *Cinchona bark. TH Foto-Werbung / Science Photo Library*

Royal Society Fellows elected 2008

The following microbiologists have been made awards: **Sir Leszek Krysztof Borysiewicz KBE FRS**, Chief Executive, Medical Research Council; **Professor Chris John Lamb FRS**, Director, The John Innes Centre and John Innes Professor of Biology, University of East Anglia; **Dr Jan Löwe FRS**, Senior Scientist, Medical Research Council Laboratory of Molecular Biology; **Professor Kenneth Nigel Timmis FRS**, Head of Department of Environmental Microbiology, Helmholtz Zentrüm für Infektionsforschung, Braunschweig.

Deaths

The Society notes with regret the death of **Dr Clifford Wray** of Pyrford, Surrey, a member since 1981.

Professor Noel G. Carr (University of Warwick), a member since 1964, died on 30 October 2007. He was a distinguished microbiologist with an international reputation in the study of cyanobacteria who pioneered molecular studies in marine microbiology.

Staff news

Congratulations to *Microbiology Today* Production Editor and Designer, **Ian Atherton** on his marriage to Alex Till on 10 May. A garden theme dominated the happy day (Ian and Alex are keen vegetable growers), and wedding guests much enjoyed partaking of the 'cake', which took the form of a pyramid of small cakes decorated with various marzipan fruits and vegetables! Ian and Alex had a brief honeymoon camping in North Wales, before returning to the daily toil of the office and garden centre, respectively.

◄ *Photo Karen Rowlett*

Feedback

Shipping news

Tony M. Davis, author of *Terrorism and the Maritime Transportation System*, writes that he recently read with interest the article, *Ship ballast tanks: how microbes travel the world* published in the May issue of *Microbiology Today*. The issue of ballast water is one to which he has devoted an entire chapter in this new book. He considers numerous non-indigenous species that enter the ports through ballast water. Many folks disregard the problem and fail to understand the economic damage and control costs. While the book covers a variety of issues generally not discussed by the press, he hopes to educate those who may in some way be affected.

◀ *Photos.com / Jupiter Images*

MRSA

Imran Hayat, Charles River Laboratories, writes that the February issue of *Microbiology Today* 'was the best I have read so far'. In particular he liked the article by Simon Foster on *Staph. aureus* because it brought attention to community-acquired MRSA, which Imran feels has been overshadowed by media preoccupations with hospital-acquired infections. He believes that improved patient awareness of the dangers of not completing a course of antibiotics properly could do much to combat and prevent MRSA, however it is acquired. Televised health advertisements, similar to the ones on the dangers of smoking, could well have a big impact. (e imran.hayat@crl.com)

Peter Wildy Prize for Microbiology Education

Dr Chris Smith of the *Naked Scientists* will deliver his prize lecture entitled *Stripping Down Science: The Naked Scientists*, on Tuesday 9 September at the Society's meeting at Trinity College Dublin. The Peter Wildy Prize is awarded for an outstanding contribution to microbiology education.

Chris is a clinical lecturer in virology and fellow of Queens' College at the University of Cambridge. He's also the founder of *The Naked Scientists*, a weekly science radio talk show, podcast and website.

He joined the combined MB/PhD programme at Cambridge University in the mid-1990s working on the development of viruses as gene therapy vectors. Mid-way through his PhD, and during his time as a junior doctor, he found working 100 hours a week was leaving him feeling under-employed, so he set up *The Naked Scientists* radio show and website.

This was initially a hobby, but it has since taken over his life, won several awards, and grown to become one of the world's most downloaded science podcasts; since 2005 over 5 million copies of the show have been distributed internationally. Chris also appears live every week on national radio in Australia and South Africa to talk about the latest scientific breakthroughs.

When he's not behind a microphone, Chris teaches and examines medical and science undergraduates at Cambridge and works as a specialist registrar in a diagnostic laboratory at Addenbrooke's Hospital, where he has a special interest in human and avian influenza and emerging viral pathogens.

Now busy completing his third and fourth popular science books, Chris also has a young daughter who ensures that his immune system remains on high alert by infecting him with everything circulating in Cambridge.

Guy Newton and antibiotic research

Guy Newton (1919–69) was an unsung hero in the history of antibiotics. He worked with Sir Edward Abraham at Oxford and in 1953 they co-discovered cephalosporin C, spawning an industry currently estimated as having a global value of US$10 billion a year. Whilst Sir Edward achieved fame as a result, Guy, who died at the age of 50, has all but been forgotten. Balliol College archivist, John Jones, has sought to give proper recognition to Newton's achievements. The results have been published in a fascinating historical essay entitled *The life and work of Guy Newton* [*J Pept Sci*, 2008, **14**, 545–555 (www.interscience.wiley.com – DOI:10.1002/psc.1014)].

Grants

Upcoming deadlines

The deadline is **26 September 2008** for receipt of applications to the following schemes:

- International Development Fund
- Watanabe Book Fund
- Elective grants
- President's Fund for Research Visits

SGM has a wide range of schemes to support microbiology. See **www.sgm.ac.uk/grants** for details and closing dates.

Enquiries should be made to the Grants Office, SGM Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG (t 0118 988 1821; f 0118 988 5656; e grants@sgm.ac.uk).

Postgraduate Student Meeting Grants

Applications for a grant to attend the SGM's Dublin meeting (8–11 September) must be received by **5 September 2008**.

Other schemes in brief

Scientific Meetings Travel Grants

The scheme supports early career microbiologists wishing to present work at a scientific meeting, either in the UK or abroad. See rules on the website for eligibility criteria.

Seminar Speakers Fund

The Fund supports talks on microbiological topics in departmental seminar programmes. Applications will be dealt with on a first come, first served basis during the academic year.

Education Development Fund/PUS Awards

Grants are available to members for projects intended to lead to an improvement in the teaching of any aspect of microbiology relevant to education in the UK. Funding is also available for small projects to promote the public understanding of microbiology, such as workshops, talks, demonstrations, leaflets, activities at science festivals. Applications will be considered on a first come, first served basis during the calendar year.

Retired Member Conference Grants

Retired members may apply for a grant to attend one SGM meeting each year. The award contributes towards en-suite accommodation and the Society dinner, up to a maximum of £250. Applications for grants to attend the SGM meeting at Trinity College Dublin are now invited.

Technician Meeting Grants

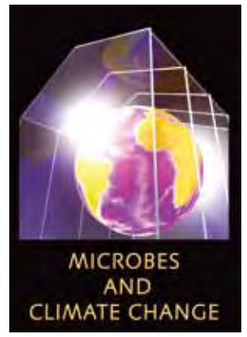
These grants support attendance by eligible technicians at one SGM meeting each year. Applications for grants to attend the SGM meeting at Trinity College Dublin are now invited.

SGM journals podcast goes live

Microbe talk: cutting-edge research uncovered

As part of an initiative to enhance SGM's presence on the HighWire site, an interview with the author of a recent paper from one of the journals will be broadcast monthly in the form of a podcast. The first interview, which was launched on Friday 13 June, was with Professor Greg Challis of the University of Warwick, a recipient of the prestigious SGM Fleming Award. His paper, based on the prize lecture delivered last year at the Society meeting in Manchester, was published in the June issue of *Microbiology*. To hear his views on research into *Mining microbial genomes for new natural products and biosynthetic pathways*, download the podcast from **www.sgm.ac.uk/news/podcast.cfm**

Microbes and Climate Change



This new and colourful 8-page leaflet has been produced by the SGM External Relations Office, mainly for use in schools where climate change is a part of the curriculum in the UK, but also for wider distribution to educate the public. Most people are unaware of the fundamental importance of micro-organisms in climate change and this publication seeks to redress the balance. It has been researched and designed by Dariel Burdass and single copies are available free by emailing **education@sgm.ac.uk**

Careers Conferences 2008

19 November – Manchester Town Hall
26 November – Royal Society, London

Aimed at life science undergraduates, each conference includes widely varying talks on career choices and further training, plus a small exhibition by a range of organizations. Under the banner, *Building a career in research*, these events are a must for students wondering what to do on completion of their degree. A CV workshop will also be available. The conferences are being organized by several learned societies, including SGM, with sponsorship from the BioSciences Federation. To register, go to **www.physoc.org**

Cost: £15, to include refreshments and lunch.

microshorts

Lucy Goodchild takes a look at some stories that have hit the headlines recently.

Algal bioreactors

Scientists at the University of Almeria, Spain, have embarked on a research project called CENIT CO_2, in an attempt to reduce the country's CO_2 emissions. A water tank would be placed next to gas emission points to retain pollutant gases, including CO_2. The polluted water would then be passed through bioreactors containing a 'microalgae culture system'. The algae would then photosynthesize, using the CO_2, producing organic matter and oxygen. The researchers say the organic matter could even be used in biofuel production, either as a substrate or as fertilizer. They hope that the system will be fully operational in a year; tests can then be started on an industrial scale.

www.alphagalileo.org/index.cfm?fuseaction=readrelease&releaseid=529524

Biofuel is just peachy

The extremophile *Thermotoga neapolitana* flourishes in deep-ocean vents in temperatures just below the boiling point of water. In the laboratory, it produces gas by-products that can contain up to 80 % hydrogen. Researchers at Clemson University, USA, have been looking at its ability to use rotten peaches to produce hydrogen, an important fuel source to combat climate change. According to the South Carolina Peach Council, 20 million pounds of peaches are discarded annually. Now, scientists are hoping that peaches unsuitable for human consumption can be turned into hydrogen biofuel. Peaches have a high sugar content and are a good substrate for *T. neapolitana*.

www.fuelcellsworks.com/Supppage8307.html

Biofuel fungus sequenced

The genome of the fungus *Trichoderma reesei* has been sequenced by researchers at the Architecture et Fonction des Macromolécules Biologiques Laboratory (CNRS/Université de la Méditerranée and Université de Provence, France). Surprisingly, they have found that only a few genes are responsible for its ability to break down plants into simple sugars. *T. reesei* was discovered during World War II, when it destroyed American military equipment despite efforts to protect it using cotton cloth; thanks to its production of cellulases, the fungus could break down cotton easily. Many industrial researchers are working to develop fungi capable of producing different cellulases in order to manufacture second generation biofuels. At first, the genetic sequence of *T. reesei* was seen in a negative light because it limits the fungus to the production of hemicellulases and pectinases. However, researchers have realized that the sequence lends itself to genetic modification and are now investigating the addition of extra genes to make its enzymic activity even more efficient.

www.nature.com/nbt/journal/v26/n5/abs/nbt1403.html

www.alphagalileo.org/index.cfm?fuseaction=readrelease&releaseid=529445

Feed microbes...

Scientists at Newcastle University and the University of Calgary, Canada, carried out a study showing how microbes use crude oil to make methane, which was published in *Nature*. Now, the researchers have set up a company called Profero Energy Inc. and have begun trials to recover oil from an exhausted deposit in western Canada. According to their research, microbes convert oil into methane gas over tens of millions of years. *Syntrophus* bacteria digest the oil and produce hydrogen gas and acetic acid, then methanogens combine

Gas-reducing grass developed

The average dairy cow can produce up to 700 litres of methane a day; it is estimated that methane released by cattle in the UK could account for 3 % of the country's total greenhouse gas emissions. In a bid to curb climate change, researchers at Gramina, a joint biotech venture by Australia's Molecular Plant Breeding Cooperative Research Centre and New Zealand rural services group PGG Wrightson Genomics is developing grass to cut the amount of methane produced by cows. According to an article in *Chemistry & Industry*, the grass is able to grow in hotter climates, allowing farmers to maintain the productivity of their herds in the face of climate change, whilst cutting methane emissions. By preventing the expression of the enzyme *O*-methyltransferase, the digestibility of the grass is increased without compromising its structural properties, therefore 'less burps and less methane'. However, some experts say overall methane production may actually increase. A diet containing more highly digestible carbohydrates would lead to the microbial production of propionic acid, which in turn would create more methane. But productivity gains would mean that less methane would be released per unit of milk. Gramina has tested its grass in the laboratory and is now planning field trials.

http://www.alphagalileo.org/index.cfm?fuseaction=readrelease&releaseid=529035

▲ Cows (*Photos.com / Jupiter*)

◀ Biodiesel (*Martin Bond / SPL*); peaches (*Photos.com / Jupiter*); Crude oil (*Paul Rapson / SPL*)

▶ Grass pollen grains (*Photo Insolite Realite / SPL*)

...to release oil

the hydrogen with carbon dioxide to produce methane. By providing the microbes with special nutrients, the geological timescale of this process could be shortened to a few hundred days in the laboratory. The researchers believe that similar results could be obtained in an oilfield in a timescale of a year to tens of years. An estimated 6 trillion barrels of oil too thick to be captured using conventional methods could be unlocked as methane using microbes.

www.alphagalileo.org/index.cfm?fuseaction=readrelease&releaseid=528952

Microbial partnership becomes magnetic

Researchers at the Helmholtz Centre for Environmental Research (UFZ) in Leipzig and the California Institute of Technology (Caltech) in Pasadena, USA, have used a new technique to determine the genetic sequence of archaea responsible for preventing the loss of oceanic methane to the atmosphere. These archaea are syntrophic organisms, working in partnership with sulfur-reducing bacteria that provide energy for the anaerobic oxidation of methane (AOM). Marine microbes can be difficult to isolate and culture in the laboratory, so the researchers developed a new technique to study the syntrophic micro-organisms. The scientists attached iron beads to the microbes and pulled them out of the sediment on the ocean floor using a magnet. The 'purified syntrophic consortia' could then be sequenced. Genes for AOM were identified and, much to their surprise, the scientists found that the archaea could fix nitrogen. There was also an unexpected diversity in the microscopic partners of the archaea. The researchers suggest the potential for metabolic diversity coupled with successful microbial partnerships could have led to their global distribution.

www.ufz.de/index.php?en=640

http://mr.caltech.edu/media/Press_Releases/PR13141.html

www.alphagalileo.org/index.cfm?fuseaction=readrelease&releaseid=529276

Probiotics protect against pollen

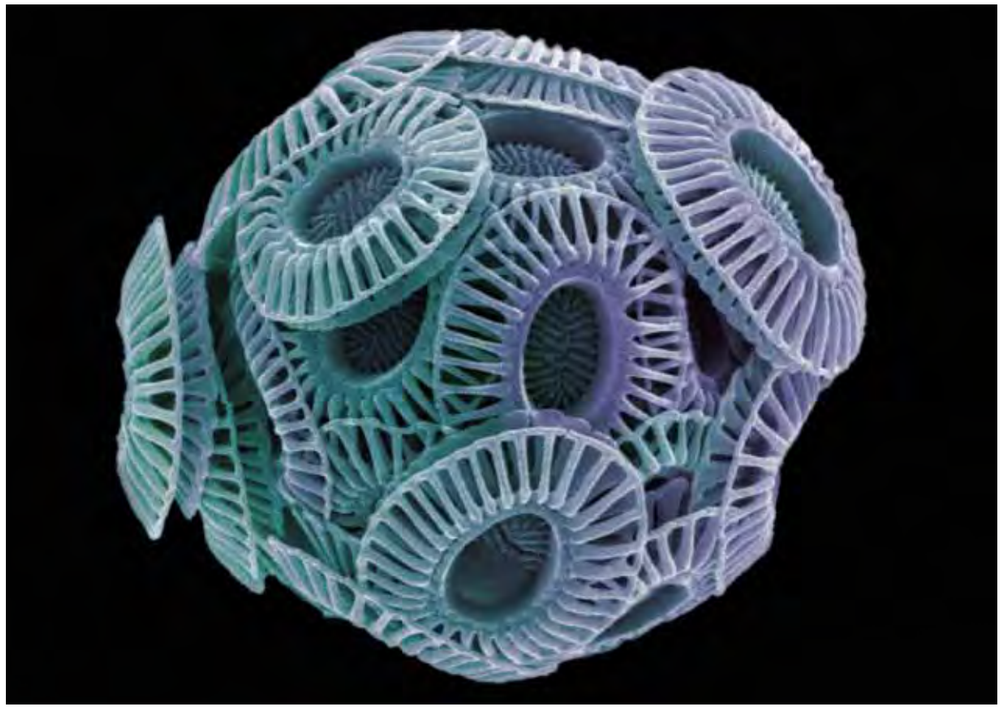
According to a pilot study carried out at the UK Institute of Food Research, a daily dose of probiotic bacteria can modify the immune system's response to grass pollen, reducing the symptoms of seasonal hay fever. The immune system can mistake fungal spores and pollen for pathogens and produce excessive amounts of the antibody IgE to fight them. This stimulates the release of histamine, resulting in the swelling of airways and typical hay fever symptoms. The study revealed that IgE levels were significantly lower in people who had taken a milk drink containing *Lactobacillus casei* compared to those in a who were given ordinary milk. Levels of IgG, which is thought to be protective against allergies, were higher in the probiotic group. Further research is planned to explain these results. Oral delivery of *Lactobacillus casei* Shirota modifies allergen-induced immune responses in allergic rhinitis.

Clinical and Experimental Allergy (2008). 1–8, doi:10.1111/j.1365-2222.2008.03025.x

www.alphagalileo.org/index.cfm?fuseaction=readrelease&releaseid=529719

Microbes and oxygen

Where does all the oxygen on Earth come from? **Martha Clokie** explores the roles of cyanobacteria and microalgae in oxygen production and gives some surprising news about the input from viruses.



Two features that distinguish planet Earth from all other known planets are the presence of water on its surface and the oxygen in the atmosphere. The oxygen is a waste product of photosynthesis and all higher life on Earth is ultimately dependent on it. The microbial contribution to oxygen in our biosphere is often under-appreciated, but in this article I will discuss how microbes oxygenated and continue to oxygenate our planet. The microbes concerned are cyanobacteria and eukaryotic microalgae. The oceans, where oxygen-producing microbes predominate, can be thought of as forgotten tropical rain forests where at least 50 % of carbon fixation and consequent oxygen production is thought to occur. This article summarizes the evolutionary and natural history of these microbes and focuses on the surprising role of viruses in oxygen production.

Cyanobacteria oxygenated Earth's atmosphere

Cyanobacteria can be considered the largest wreakers of environmental havoc the Earth has ever experienced, probably causing in the past the demise of a large proportion of the bacteria and archaea that predominated before they came on the scene. Until around 2.6 billion years ago the Earth's atmosphere was largely composed of carbon dioxide, carbon monoxide, nitrogen and water. Plenty of non-oxygen-producing photosynthetic bacteria existed before cyanobacteria, generating chemical energy by using energy from light to remove an electron from available molecules and passing it through a chain of proteins to reduce molecules such as sulfur. Cyanobacteria adapted the photosynthetic machinery in many ways, including using water as their electron source and oxygen as their terminal electron acceptor. After their appearance, the atmosphere was gradually oxygenated to the current levels of around 21 % oxygen.

From cyanobacteria to photosynthetic phytoplankton

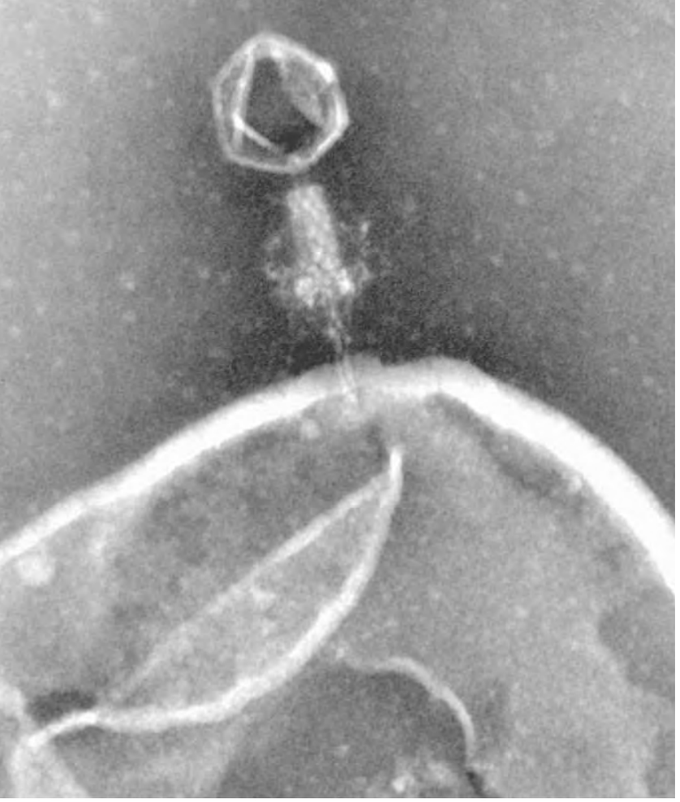
This oxygen-producing apparatus was only invented once, but it was then acquired by many lineages. The cyanobacteria were consumed by heterotrophic eukaryotes which retained their genome as a plastid. Further endosymbiotic and horizontal gene transfer events eventually gave rise to a plethora of lineages of primary producers that constitute the higher plants and the far more diverse algae, of which the photosynthetic phytoplankton are a subset.

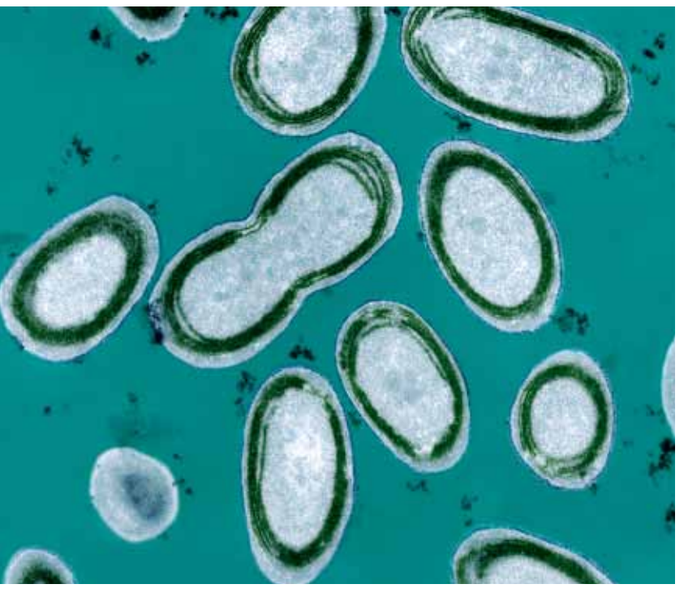
The key players in oxygen production

Despite all the acquisition and evolution of cyanobacterial genomes, cyanobacteria themselves remain important oxygen producers. Indeed marine cyanobacteria together with photosynthetic phytoplankton are thought to contribute equally to the global carbon fixation which amounts to half the total annual amount fixed, and therefore half the amount of oxygen produced. However, the identity and composition of the key players, particularly of the photosynthetic phytoplankton components, are poorly understood. These microbes are referred to as nanoplankton or picoplankton, depending on their size, and new classes are still frequently being discovered. Often this is based on molecular data

▲ Composite satellite image of Earth's western hemisphere, centred on the Atlantic Ocean. *NASA Earth Observatory / Science Photo Library*

◀ Coloured scanning electron micrograph of the haptophyte *Emiliana huxleyi*. *Steve Gschmeissner / Science Photo Library*





◀ Bacteriophage S-PM2 infecting a *Synechococcus* cell. *Stefan Hyman & Natalie Allcock, School of Biological Sciences, University of Leicester*

▼ Coloured transmission electron micrograph of a section through *Prochlorococcus* cells. *Claire Ting / Science Photo Library*

and they are difficult to isolate from the oceans and to culture. Important algal contributors to open ocean carbon fixation are the green algal flagellates, the heterokonts (a diverse group including the diatoms) and the haptophytes (including the calcite-precipitating *Emiliana huxleyi*); both these groups have red algal plastids.

Cyanobacterial distribution

As less is known about the distribution of photosynthetic phytoplankton, I will focus on the cyanobacteria which are found in most places where water exists, playing important environmental roles such as stabilizing desert sand for the colonization of other plants. They thrive in fresh water, salt lakes and hot springs, but are most numerous in the oceans where up to a million cells may be present per millilitre of sea water. By virtue of extremely efficient light-harvesting and nutrient-assembling machineries, surprisingly just two genera, *Synechococcus* and *Prochlorococcus* dominate the nutrient-poor oligotrophic areas of the open ocean where higher plants and even microalgae cannot survive. Their distribution changes according to ocean temperature, light availability and nutrient status. *Synechococcus* is the hardier of the two and it dominates in water with a latitude of more than 40°; *Prochlorococcus* is the softer cousin and is numerically superior in warmer waters.

Molecular studies based initially on ribosomal DNA and subsequently on whole-genome analysis have allowed us to further understand the relationships, distribution and physiology within *Synechococcus* and *Prochlorococcus*. Both genera can be divided into multiple clades or lineages. *Prochlorococcus* lineages are primarily correlated with light availability; the distribution of *Synechococcus* clades is less clear, but they are correlated to some extent with nutrient status and the temperature of the water column.

Oxygen-producing physiology

The proteins at the heart of the photosynthetic machinery where light energy is converted into chemical energy are called D1 and D2. They are encoded by the genes *psbA* and *psbD*. In a normally functioning cyanobacterium or plant there is a high turnover of these proteins, in particular D1. They are damaged by light, so new copies are constantly being generated and inserted into the photosystem to maintain active photosynthesis. Unlike higher plants, some cyanobacteria have multiple copies of the *psbA* gene. Different versions are used under specific environmental conditions with some versions being more efficient when the cyanobacteria are light-, temperature- or nutrient-stressed, and this allows them to survive where photosynthetic phytoplankton cannot.

Viruses and oxygen production

A twist on microbial oxygen production comes from our recent appreciation of the role of viruses in cyanobacterial ecology. Marine cyanobacteria are constantly under attack by viruses, and the turnover rates are thought to be as high as 50 % of all cyanobacteria lysed each day. The dynamics of viral infection are not uniform; many cyanobacterial viruses appear to be dependent on light to absorb to their hosts. Both cyanobacterial and algal viral infection are dependent on efficient photosynthesis for viral replication to occur.

Information from virus genome sequencing has revealed the presence of key genes involved in photosynthesis, including those which encode D1 and D2. This was a huge surprise as photosynthesis was not considered to be something that viruses could do. The viral versions of the gene are highly conserved at the amino acid level, but vary considerably at the nucleotide level. Phylogenetic analyses indicated that these genes originated in cyanobacteria and were subsequently acquired by viruses.

It appears that after the viruses infect the cyanobacteria, they shut down host photosynthesis machinery and provide their own alternative versions of the proteins necessary to maintain photosynthesis. This provides the viruses with enough energy to replicate.

Viruses: friends or foe?

It is not known how efficient the virus-encoded photosystem is compared to that encoded by the cyanobacteria. Modes of cyanobacterial viral infection are complex and they may infect and express their genes but not cause cell death in a process known as pseudolysogeny. During pseudolysogenic infection, cells expressing the viral version of *psbA* may be more efficient photosynthesizers than those with the cyanobacterial versions. Thus the viruses are acting as pseudosymbionts. Infected cyanobacteria will then reproduce more efficiently than uninfected cells, thus producing both more cyanobacteria and more viruses. A further unresolved question is. are viruses capable of 'donating' their versions of *psbA* back into the cyanobacterial community? Finally, are there parallels in the algal world? As I pointed out above, we are still unclear about many of the most important microalgal groups, let alone the composition and importance of their viral community. Viruses that have been studied have large complex genomes which suggests that they play multiple roles in host physiology.

Final thoughts

I have briefly described the who, when, where and the how when it comes to microbial oxygen production. I will leave you with the back of the envelope calculation that leads us to tentatively speculate that if half of the oxygen produced per year occurs in the oceans, and half of this is derived from cyanobacteria of whom half are infected by viruses at any one time, then up to one-eighth of the total oxygen we breath may have passed through the photosystem encoded by a virus.

Martha Clokie
Department of Infection, Immunity and Inflammation, Medical Sciences Building, University of Leicester, PO Box 138, Leicester LE1 9HN, UK (t 0116 2522959; e mrjc1@leicester.ac.uk)

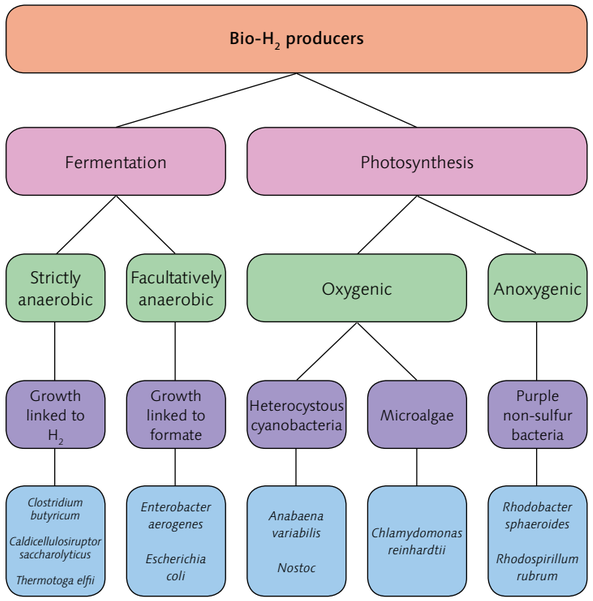
Further reading

Clokie, M.R.J. & Mann, N.H. (2006). Marine cyanophages and light. *Environ Microbiol* 8, 2074–2082.

Falkowski, P.G. & Knoll, A.H. (2007). *Evolution of Primary Producers in the Sea*. Academic Press.

Lane, N. (2002). *Oxygen: The Molecule that Changed the World*. Oxford University Press.

Life's a gas ... and it's hydrogen



▲ Biohydrogenic micro-organisms.

► H_2 is the only fuel with sufficiently high energy content for space exploration and its single combustion product is water, hence it is environmentally 'clean'. *Comstock Images / Jupiter Images*

Hydrogen (H_2) contains around three times more potential energy by weight than petrol, making it the highest energy-content fuel available, a property exploited in space exploration. Perhaps unsurprisingly, a multitude of micro-organisms have developed the ability to derive energy from H_2, but this is not the focus of this short article. Paradoxically, there are special and yet prevalent circumstances under which micro-organisms have no better way of gaining energy than to release H_2 into their environment. The study of these phenomena began early in the last century, but biohydrogen (biologically produced H_2) remained merely an academic curiosity before the fuel crises of the 1980s. The rising profile of energy issues in the public consciousness and in political agendas, combined with scientific advances and the expansion of interdisciplinary research, have contributed to a fresh revival and new developments in biohydrogen technologies.

Biohydrogen production by microbes

The capacity for biohydrogen (bio-H_2) production is associated with the activity of either of two very common enzymes (hydrogenase and nitrogenase), but the shortlist of candidates targeted for focused study represents relatively few classes, including the fermentative bacteria and photosynthetic micro-organisms such as cyanobacteria, microalgae and purple bacteria. The ways by which these produce H_2 are summarized in the diagram on the left.

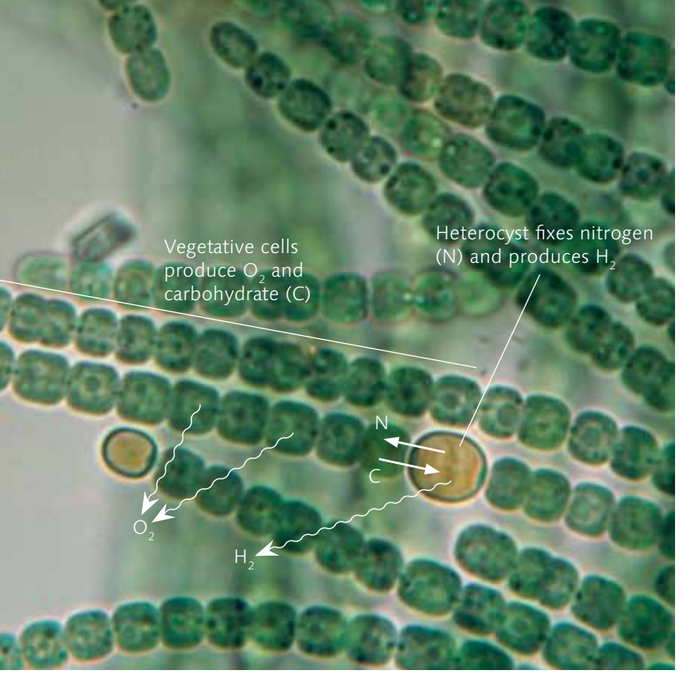
The mechanisms of bio-H_2 production within these groups are diverse, but some generalizations can be made. First, bio-H_2 production is strictly an anaerobic phenomenon because both hydrogenase and nitrogenase enzymes are destroyed by oxygen. Second, the circumstances under which it occurs always challenge the cell in some way, be it to dispose of excess reducing power, to dispatch a toxic substance or to cope with the absence of an important nutrient.

For example, in anaerobic fermentation H_2 is produced from oxidizable carbohydrates like sugars, and the generation of ATP is inextricably linked to the release of reducing power, which must be deposited onto a suitable acceptor for the fermentation to proceed. In the cases of strictly anaerobic bacteria, hydrogenase enzymes can function to 'dump' the excess reducing power onto H^+, forming H_2. Therefore the fermentation is so dependent upon H_2 production that feedback inhibition caused by the produced H_2 stalls growth if H_2 is not allowed to escape. Facultative bacteria carry out a similar reaction, but in this case H_2 is produced primarily via the decomposition of formic acid, a mildly toxic fermentation product, hence the connection between growth and H_2 production is indirect.

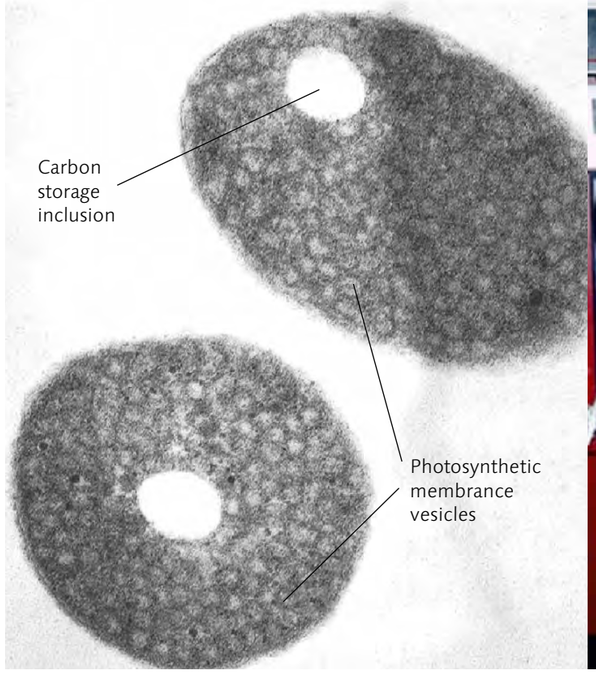
Seeing the light

In contrast to the dark world of fermentation, photosynthetic micro-organisms have tapped into the Earth's most abundant

The ability of certain microbes to generate hydrogen gas has many exciting potential applications according to **Mark Redwood** and **Lynne Macaskie**. One new development uses biodegradable wastes that would normally go into landfill to make biofuel.



▲ H_2 production by heterocystous cyanobacteria occurs due to the exchange of nutrients between specialized cell-types; heterocysts and vegetative cells. *John Walsh / Science Photo Library*



▲ Purple bacteria. Sections of *Rhodobacter sphaeroides* cells showing inclusions of carbon-storage polymer (poly-β-hydroxybutyrate: the clear bodies) and photosynthetic membrane vesicles. *Mark Redwood*

▲ Made for each other? Dark (left) and light (right) bio-H_2 reactors co-operate to make bio-H_2 with high efficiency. The fan (arrowed) is powered by a fuel cell which generates electric power from bio-H_2. *See movie at http://bst.portlandpress.com/bst/033/bst0330076add.htm*

energy source: sunlight. When photosynthesis is in full swing energy is plentiful and H_2 production results from the need to overcome different barriers. Access to light energy enables photosynthetic micro-organisms to live by endothermic chemical reactions, which could not support life in darkness. For example, anoxygenic photosynthetic bacteria (APB) are able to derive carbon for growth from relatively inaccessible substrates, including organic acids, such as those formed in the process of dark fermentation. This metabolism releases reducing power from the substrates, which must be disposed of so that more substrate can be processed (hence the term photofermentation). APB solve this problem by producing highly reduced storage material (e.g. poly-β-hydroxybutyrate) and, when they are limited for their nitrogen supply, by fixing atmospheric nitrogen. This is where nitrogenase makes a dramatic entrance. This enzyme functions to split the N_2 molecule to form 'ready nitrogen' (NH_3), a reaction requiring an enormous activation energy to break the N≡N triple bond, one of the strongest bonds found in nature. Power comes at the expense of selectivity and here H_2 is formed as a wasteful byproduct. However, the purple bacteria can be fooled into running nitrogenase even though N_2 is absent, so that only H_2 and not NH_3 is produced.

▲ Fermentative bacteria consume sugary substrates to produce hydrogen and smelly organic acids requiring disposal. *Courtesy Geoff Gadd*

Different branches of photosynthetic micro-organisms (including cyanobacteria and microalgae) carry out oxygenic photosynthesis, so-named because it generates oxygen. Since hydrogenase and nitrogenase are destroyed by oxygen, H_2 production by oxygenic micro-organisms relies on separating the production of H_2 and O_2 either in space or in time. The simplest way of doing this is termed 'indirect photolysis' as it involves the photosynthetic generation of carbohydrate by day, followed by its decomposition by night when the photosynthetic supply of oxygen ceases, allowing H_2 to be generated by anaerobic fermentation. Conversely, according to 'direct photolysis', the reducing power generated by photosynthesis is dissipated by hydrogenase enzymes, such that the complex pathway can be approximated to water-splitting: $H_2O \rightarrow H_2 + {}^1/_2O_2$. Nitrogen-fixing cyanobacteria form chains of connected cells (filaments). Like the purple bacteria, the cyanobacteria use nitrogenase to access 'ready nitrogen', but due to the abundance of damaging oxygen, it is necessary to protect nitrogenase in a specialized anaerobic cell called a heterocyst. Nitrogenase can function only in the heterocyst because the oxygen-producing part of the photosynthetic machinery is absent, but the crippled photosystem is unable to produce enough energy for carbohydrate production, so it is dependent upon its vegetative neighbours to provide carbohydrate in exchange for 'ready nitrogen'.

This situation has been recreated artificially using sulfur-deprived microalgae, which cannot maintain the oxygenic part of the photosynthetic apparatus during a shortage of sulfur.

Light and dark: a new way to help save the planet

Such biochemical phenomena provide endless fascination for scientists, but increasing attention is becoming focused on applying this knowledge to address some of mankind's worsening problems. Recent work at the University of Birmingham focuses on combining dark fermentation and photofermentation to generate H_2 from sugary feedstocks. These two bioreactions fit together as the organic acid products of dark fermentation represent the ideal substrates for purple bacteria. When assembled in the laboratory, the bioprocess represents an everyday process occurring in nature where the two types of bacteria co-exist, but in the bioprocess the two bioreactors are optimized to provide the ideal conditions for H_2 production by the two different mechanisms. The maximum quantity of H_2 that could be potentially recovered from sugary feedstocks is 12 mol H_2 per mol hexose unit, but this kind of efficiency cannot be approached by a single organism. The dual bioreactor process can approach this maximum by producing up to 4 mol H_2 in the dark reactor and up to 8 mol H_2 in the photobioreactor. A significant challenge for the development of this process to a productive scale is to design a kind of photobioreactor that is cheap to construct and capable of capturing light from a large area and transmitting it into the photosynthetic culture. A second issue is connecting the process with a reliable supply of sugary feedstock.

Immense quantities of suitable substrates can be found in biodegradable wastes, which if dumped into landfill would generate landfill gases, including methane, a greenhouse gas 25 times more potent than CO_2. For example, a third of all household food is wasted in the UK, totalling 7 million tonnes a year. However, this represents only a fraction of the actual food-linked waste as the UK food industry generates at least a further 6 million tonnes of biodegradable waste annually. With a more advanced pre-treatment, bio-H_2 can even be produced from the cellulosic residues from food-crop cultivation (e.g. corn stalks and husks), which represent tens of millions of tonnes annually in the UK. Diverting these wastes from landfill into bio-H_2 production addresses both climate change and energy security.

In a final twist, the hydrogenase in the leftover bacterial cells can be used to scavenge precious metals from spent automotive catalysts to make the catalytic ingredients of the fuel cell that converts H_2 into electricity. Hence nothing is wasted and an important new application can be found for today's waste mountain in tomorrow's non-fossil fuel transport and energy.

Mark D. Redwood
Research Fellow

Lynne E. Macaskie
Professor of Applied Microbiology

Unit of Functional Bionanomaterials, School of Biosciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK
(t 0121 414 5434; f 0121 414 5925; e m.d.redwood@bham.ac.uk; l.e.macaskie@bham.ac.uk)

Further reading

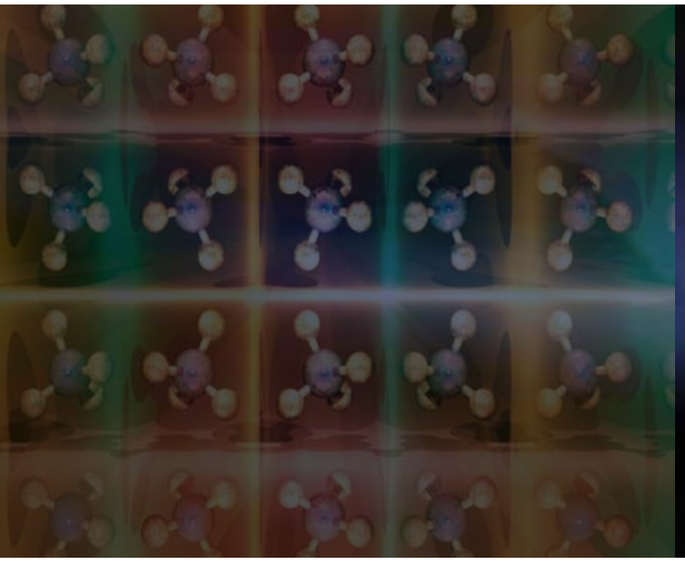
Baxter-Plant, V.S., Mabbett, A.N. & Macaskie, L.E. (2002). Bacteria, their precious metal armour and a new weapon against waste. *Microbiol Today* **29**, 80–81.

Kapdan, I.K. & Kargi, F. (2006). Bio-hydrogen production from waste materials. *Enzyme Microb Technol* **38**, 569–582.

Macaskie, L.E. & others (2005). Applications of bacterial hydrogenases in waste decontamination, manufacture of novel bionanocatalysts and in sustainable energy. *Biochem Soc Trans* **33**, 76–79.

Redwood, M.D., Paterson-Beedle, M. & Macaskie, L.E. (2008). Integrating dark and light biohydrogen production strategies: towards the hydrogen economy. *Rev Environ Sci Technol* (submitted).

Waste and Resources Action Programme (April 2008). *The Food We Waste*. http://wrap.s3.amazonaws.com/the-food-we-waste.pdf



Methane: a natural gas

The methane produced by microbes is a big contributor to global warming, but as **Setareh Nazaries** and **James Chong** describe, it also has great potential as a source of green energy.

Some believe that methanogens may be among the most ancient forms of life. What is the evidence for this? These single-celled prokaryotic organisms belong to the domain *Archaea*, itself a lineage of cells that appear to be deeply rooted between the eubacteria ('true' bacteria) and the eukaryotes. Archaea were originally called archaebacteria until the 'Archaea-ologists' felt a name that more obviously demonstrated the differences between these organisms and eubacteria was required. While the archaea are best known for their love of extremes – the most thermophilic, acidophilic, halophilic (salt-loving) and barophilic (pressure-loving) organisms all belong to this domain – most methanogens show distinctly mesophilic tendencies. However, methanogens require an environment containing less than 10 p.p.m. O_2 (i.e. <0.001 %) to grow! For most oxygen-requiring life, this could be considered to be rather extreme. This very low oxygen concentration coincides with the probable composition of the atmosphere of anoxic Earth some 2.5 billion years ago, before the 'great oxygenation event' that was triggered by the evolution of microbial photosynthesis. Methanogens have evolved a unique metabolism that allows them to survive on the energy generated by the reduction of CO_2 and other small carbon compounds by hydrogen. This is not a particularly energetically favourable process and results in the biological generation of methane as a waste product (hence the name). The 'methanogens-as-one-of-the-earliest-forms-of-life' theory suggests that methane excreted by methanogens could have helped to warm primordial Earth.

Biological methane

Methanogens are the main source of biological methane on the planet, producing in the order of a billion tonnes per annum globally. Methane is a serious greenhouse gas with 23 times the global warming potential (GWP) of CO_2 over 100 years. That is, a single molecule of methane released into the atmosphere has the same thermal retention capacity as 23 molecules of CO_2 over 100 years. The warming effect of methane is even worse over a shorter time scale – it has a GWP of 68 over 20 years – but it is a relatively unstable molecule once in the upper atmosphere. Contemplating the numbers is a rather frightening prospect: if all the methane produced by methanogens each year reached the atmosphere, it would be the equivalent of releasing 23 billion tonnes of CO_2. Current global CO_2 emissions are about 8 billion tonnes per year; thus, methanogens have the potential to provide three times the heating effect of anthropogenic carbon emissions! Fortunately, a large proportion of methanogen-produced methane is captured by other, methanotrophic, bacteria that can in turn use methane as an energy source.

◀ Computer models of methane molecules. *Prof. K. Seddon & J. Van Den Berg / Queen's University, Belfast / Science Photo Library*

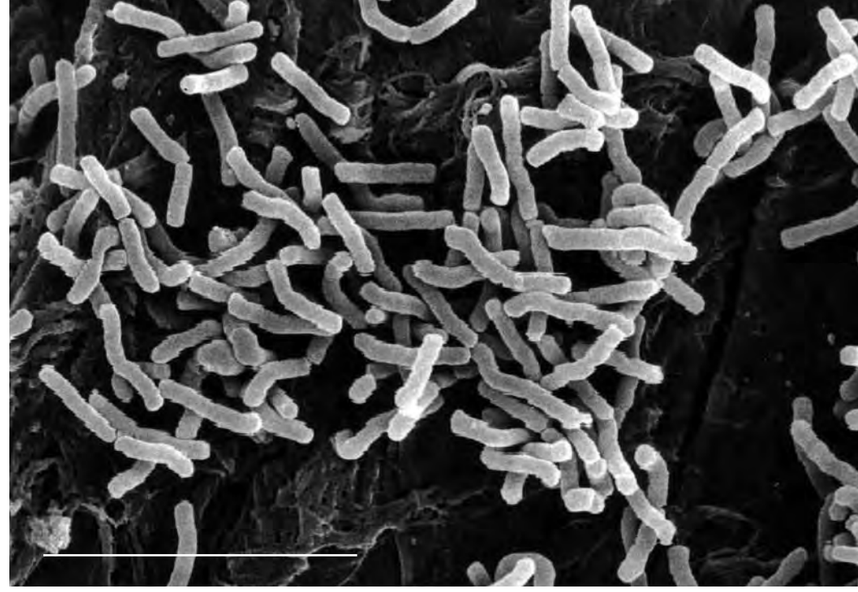
▲ Natural gas burning. *Photos.com / Jupiter Images*

Biofuel potential

Of course, not only methanotrophs can use methane for energy. The major flammable component of natural gas is methane. Natural gas is currently the fossil fuel of choice due to its relatively clean burning properties and it provides more than 40 % of current energy needs in the UK. Methane is an odourless gas (if you work with methanogens you always need to get this into the conversation early!) that is relatively easy to handle, and burns with oxygen to produce only water and CO_2. Two of the main problems with natural gas/methane as a fuel source are the production of CO_2 and the fact that as a fossil fuel, natural gas is a finite source of energy. Methane from methanogens does not have the same problems. Methanogenic methane is renewable, and formed from recently fixed atmospheric CO_2, so burning methane from a methanogenic source is effectively carbon neutral.

Anaerobic digestion

In the microbial world, methanogens are terminal electron acceptors, taking the breakdown products from



consortia of (mainly) constitutively anaerobic bacteria at the end of the organic degradation process. Anaerobic digestion (AD) has long been used as a low-tech, environmentally friendly, way to process organic waste into 'biogas'. Biogas is a mixture of CO_2 and methane that can be burned in much the same way as natural gas to provide both heat and power. Anaerobic digesters tend to be more popular in countries with warmer environments where the natural processes involved in organic matter breakdown are perceived as faster. However, a number of facilities exist in the UK (mainly for processing wastewater) that also make use of methanogens. AD has also seen a recent rise in popularity in continental Europe, where incentives for green energy production have made electricity generated from biogas a cost-effective method of disposing of plant and other agricultural waste. In the USA in 2000, the amount of electricity produced by AD from agricultural sources was insignificantly low. However, by 2007 agricultural AD from a relatively small number of facilities in the USA was responsible for the production of more than 215,000,000 kWh of electricity, emphasizing how rapidly and effectively this technology can be deployed.

In the UK, AD is still a very underused technology despite Defra recently making it the preferred method for disposing of food waste. AD is perceived as an unreliable and difficult technology to use in the UK – something that works better at higher ambient temperatures. There is no scientific basis for these notions. The Arctic tundra has been estimated to contain as much as 32,000 Gt (1 Gt = 10^9 tonnes) of methane generated by the slow action of methanogenic degradation of organic matter trapped under the permafrost. So methanogens and their associated consortia of anaerobes can certainly tolerate the British climate. Methanogens, perhaps due to their great ancientness, or perhaps due to the pervasiveness of oxygen forcing them to hide, have been found in all of the anaerobic ecological niches explored to date. There are thermophilic methanogens (the first archaeal genome to be sequenced was of the hyperthermophilic *Methanocaldococcus jannaschii*, which grows at 85 °C), halophilic methanogens and psychrophilic methanogens (isolated from Antarctica).

Methanogen habitats

Alessandro Volta (the scientist who first described the Volt) was the first person to describe methane from microbes, which he observed by igniting 'combustible air' collected from marshes in northern Italy in 1776. As well as being hugely abundant in rice paddies, swamps and landfill sites, methanogens are endemic in ruminants (responsible for as much as 15 % of global methane emissions), termites and other insects (5 % of global methane emissions are due to methanogens in termite guts). The limited studies that exist concerning the presence of methanogens in human guts vary wildly, but it seems likely that more than 30% of the population contain methanogens in their guts, and that their presence is good for your gut flora.

Growing pains

Despite their abundance, growing methanogens in the laboratory poses a significant challenge; gases need to be scrubbed of all traces of oxygen, and hydrogen must be handled in a non-explosive manner. Large quantities of strong reducing agents (mainly sulfur-containing compounds) do lend a certain pall to the atmosphere that perhaps justifies the initial reaction many people have to the thought of working with methanogens – this kind of microbiology can be smelly! However, growing methanogens alone is nothing compared with trying to grow a stably-interacting mixed population of anaerobes. But in order to understand the dynamics that occur in these consortia, these issues must be resolved. Consortial dynamics need to be measured, understood and modelled so that the robust but rather inefficient process of anaerobic digestion can be improved and added to the range of green energy/biofuel options currently being examined as alternatives to mankind's dependence on fossil fuels. This is a microbiological challenge that should no longer be neglected.

Setareh Chong & **James Chong**
Department of Biology (Area 5), PO Box 373, University of York, York YO10 5YW, UK (t 01904 328628; e jpjc1@york.ac.uk)

Further reading

United States Environmental Protection Agency (2006). Global anthropogenic non-CO_2 greenhouse gas emissions: 1990–2020. www.epa.gov/nonco2/econ-inv/international.html

Defra (2008). *UK Greenhouse Gas Inventory, 1990 to 2006*. ISBN 0-95548-234-2.

www.defra.gov.uk/corporate/ministers/speeches/joan-ruddock/jr071016.htm

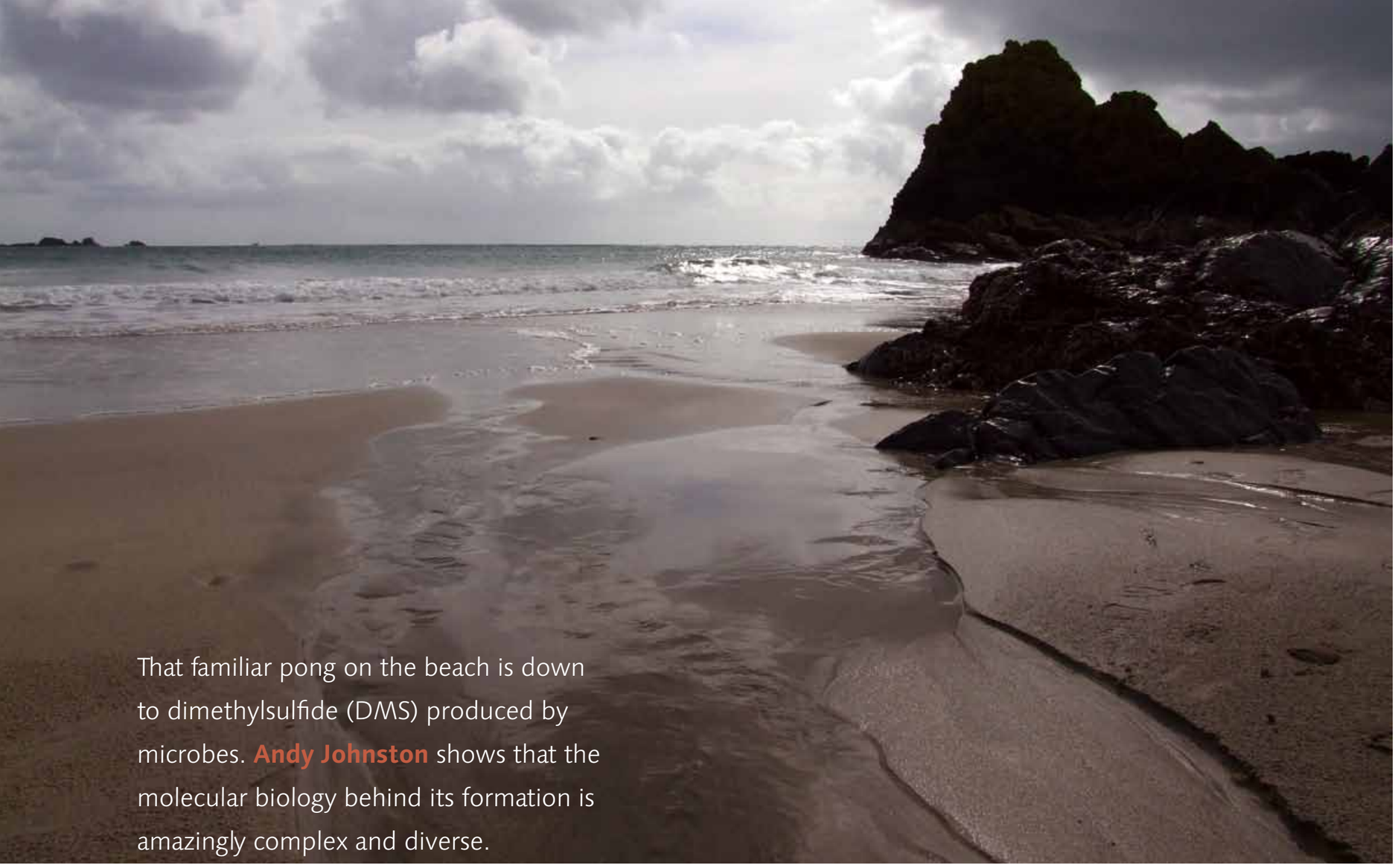
Semiletov, I., Shakhova, N., Romanovsky, V. & Pipko, I. (2004). Methane climate forcing and methane observations in the Siberian Arctic land-shelf system. *World Resour Rev* 16, 503–542.

▲ *Top left.* Microscale methane generation. Termites are equipped with portable anaerobic digesters that contain a huge diversity of specialized microbes for the breakdown of lignocellulose. *Photos.com / Jupiter Images*

▲ *Top right.* A scanning electron micrograph of *Methanothermobacter thermautotrophicus*. This organism was originally isolated from sewage sludge and grows optimally at 60 °C. Bar, 5 µm. *Meg Stark & Paul McDermott*

◀ *Far left.* Methanogens growing in captivity. A 2 litre culture of *Methanococcus maripaludis* growing on an 80:20 mix of H_2 and CO_2. Methane is produced as a waste product by all methanogens. *James Chong*

◀ Sushi and burgers make methane. Paddy fields are one of the major anthropogenic methanogen niches that are expanding. In 2005, global rice cultivation was responsible for the emission of ~32 million tonnes of methane (the equivalent of 672 million tonnes of CO_2) – more than the UK's total greenhouse gas emissions for the same year. Global enteric fermentation produced nearly three times this amount of methane (92 million tonnes) in 2005. *James Chong*



That familiar pong on the beach is down to dimethylsulfide (DMS) produced by microbes. **Andy Johnston** shows that the molecular biology behind its formation is amazingly complex and diverse.

▲ Kynance Cove, Cornwall. *Ian Atherton, SGM*

On the microbial genetics of seaside smells

Ever walk along the shore, taking in that tangy aroma? Ever wonder how ocean birds, such as Shearwaters find their lunch and dinner over the featureless wastes of the Atlantic? Or why seals poke their noses above water, taking in the air? Ever ask how clouds form over the oceans? Many questions, but just one answer – dimethylsulfide (DMS), a gas with many influences and one, like the others in this issue, which is made by microbial action.

The great savant, James Lovelock, realised 40 years ago that DMS is the pre-dominant form of sulfur that escapes from the seas to the air and thence back to land, thus completing the global sulfur cycle. (Bizarrely, the received wisdom of that time was that the culprit was hydrogen sulfide, a gas with a very different aroma!)

We now know that around 50 million tonnes of DMS emerge from the oceans and their margins, but this is just a 'drop in the ocean' (around 10 %) of the total annual production. The most important effect of DMS is that it is oxidized in the air to form sulfates, which in turn form cloud condensation nuclei which affect local weather and, perhaps, world climate. Thus, one of those earlier questions is answered, but to address the others, we must know the provenance of the starting material for DMS production.

The source material, dimethylsulfoniopropionate

The substrate for DMS production is dimethylsulfoniopropionate (DMSP), with around one billion tonnes of this metabolite being cycled each year. As if this were not enough, its catabolic legacy, as DMS, further adds to its importance – yet how many of us are familiar with this compound? DMSP is among the most abundant intracellular molecules in the myriads of single-celled phytoplankton, including many haptophytes, whose forebears formed, among other places, the White Cliffs of Dover. It also occurs in macroalgal seaweeds and in a few known land plants. DMSP is a compatible solute, protecting cells against UV, oxidative and osmotic challenges, but there is still some debate about its precise role(s). What is clear, though, is that microbes catabolize DMSP in various ways – on a massive scale, and with global consequences.

As far back as 1956, a red algal seaweed, *Polysiphonia*, that makes DMSP, was shown to catabolize it, via an enzyme called DMSP lyase that would also generate acrylate plus a proton. Indeed, many plankton that make DMSP can also degrade it when stressed, perhaps liberating the resultant DMS and acrylate as defence or signalling molecules. However, the majority of DMSP catabolism is mediated by marine bacteria, some of which can grow on it as their sole carbon source. These include strains of the *Alpha-* (various *Roseobacter* spp.), *Beta-* (*Alcaligenes*) and *Gammaproteobacteria* (e.g. *Vibrio*).

Bacteria degrade DMSP in at least two very different ways. In one, it is demethylated, the thiol products being used as sources of both carbon and sulfur. The other general mechanism releases DMS, which acts as a chemoattractant beacon for those seabirds, seals and other animals that eat plankton, or their cohabiting fish and crustaceans – and, for us, it contributes to that sentient seaside smell.

Despite its importance, and the ease of cultivating many bacteria that degrade DMSP, not one gene involved in the process had been identified until 2006. However, recent studies have begun to provide some genetic insights, although, in reality they set more questions on topics that range from enzymology to evolution.

The *dmd* and *ddd* genes for bacterial catabolism of DMSP

The first reported gene for DMSP catabolism was *dmdA*, which encodes DMSP demethylase, the initial step in the demethylation pathway. Found by Mary Ann Moran's lab in a strain of the abundant *Roseobacter* clade of the marine *Alphaproteobacteria*, close homologues of DmdA occur in other marine alphaproteobacteria, including the SAR11 bacterium *Pelagibacter ubique*, the most populous organism on the planet.

Then, the first of the *ddd* (DMSP-dependent DMS) genes was found in the gammaproteobacterium *Marinomonas*, isolated from roots of the grass *Spartina*, one of the few angiosperms known to make DMSP. A single cloned gene, called *dddD*, was enough to confer to *Escherichia coli* the ability to make DMS when grown on DMSP – as detected by the evocative aroma from the Petri dishes. However, the DddD polypeptide was not the expected DMSP lyase, but was an acyl-CoA transferase that could add CoA to DMSP. The predicted DMSP-CoA product is unstable, and could spontaneously release DMS, plus acryloyl CoA, with the latter being further catabolized for growth on DMSP as carbon source.

Strikingly, DddD was lacking from the deduced proteomes of several bacteria that are known to make DMS from DMSP and whose genomes had been sequenced. So, there must be different ways to make DMS, something that had been implied by work by Duane Yoch some time ago.

One such 'alternative' system is specified by the *dddL* gene, which was identified in *Sulfitobacter*, a *Roseobacter*-type marine bacterium. The DddL polypeptide, which had no homologues with known function, may be the long-predicted DMSP-lyase, since *E. coli* that expresses *dddL* makes acrylate plus DMS.

▲ Close-up of tetraspores of the red alga seaweed *Polysiphonia nigrescens* from Devon. *D.P. Wilson / FLPA-images.co.uk*

▼ Salt grass (*Spartina alterniflora*), one of the few angiosperms known to make DMSP. *John Bova / Science Photo Library*

Gene sampling of the oceans from the comfort of one's laptop

Thanks to the industrial-scale sequencing of the partial genomes of uncultured marine bacteria, done largely by Craig Venter's Global Ocean Survey and other projects supported by the Moore Foundation, one can survey any given gene in the seemingly astronomical list of genes in these metagenomes. Of the genes mentioned above, *dmdA* is the clear 'winner' with hundreds of hits in these marine gene databases, in keeping with the importance of demethylation at a global level and the finding of *dmdA* in *P. ubique*. The *dddL* and *dddD* genes rather trail behind, with nine and six apiece, but even these relatively low numbers represent trillions of total *dddD* and *dddL* genes, in bacteria strewn around the planet's oceans. Of course, numbers are not everything, and the levels of expression and activities of the enzymes will also contribute to the fluxes through the different pathways.

Rampant gene transfer – among unexpected bedfellows

The *ddd* genes are prone to widespread horizontal gene transfer (HGT), in some cases to totally unexpected organisms. *dddL* is the least promiscuous, being found only among occasional strains of the Order *Rhodobacterales*, though even here, there was one nice surprise. Going back to Cornelius van Neil's studies in the 1930s, *Rhodobacter sphaeroides* is something of a lab rat for studies on bacterial photosynthesis, motility and bioenergetics, but it had never been suspected of making DMS. However, of three strains of *R. sphaeroides* sequenced in Sam Kaplan's lab, two had a close DddL homologue and one did not. Gratifyingly, their DMS-producing phenotypes were entirely as predicted from their genomes.

The other gene, *dddD* is much more adventurous. It was not totally surprising that DddD also occurs in other, known DMS-emitting marine bacteria such as *Sagittula*. Even here though, *Sagittula* is an alphaproteobacterium, so presumably it acquired (or donated) *dddD* by HGT from/to the rather distantly related gammaproteobacterium *Marinomonas*. But, wholly unexpected was the presence of DddD in some terrestrial bacteria, which interact with angiosperm roots. These included some strains of root-colonizing *Burkholderia* (*Betaproteobacteria*) and a highly unusual strain (NGR234) of *Rhizobium*, which forms nitrogen-fixing root nodules on many different legumes and even (uniquely) on some non-legumes. Perhaps these root-dwelling bacteria associate with some, unknown, angiosperms that, like *Spartina*, make DMSP.

What next?

These are early days, but it seems likely that there will be good progress in elucidating the biochemistry of the entirety of the various DMSP catabolic pathways. However, this article started with rhetorical questions, and ends with real ones, prompted by these tantalizing glimpses into the genetics of DMS production. Why do bacteria use the DMS-producing pathway in the first place, when demethylation would allow them to recoup all the C and S, and not see much of it drift off into the seas and the skies as DMS? This is particularly pertinent to strains that contain both demethylation and DMS-emitting pathways. How and why do they 'choose' which system to use under any given set of environmental circumstances? What are the constraints (if any) to HGT of the *ddd* genes. And finally, there are still many environments such as corals and the tissues of some invertebrate animals, like clams, that are awash with DMSP but whose microbiology has not been examined, certainly not at a molecular genetic level. What other surprises lie in wait in the deeps?

Andrew W. B. Johnston
School of Biological Sciences, University of East Anglia, Norwich NR2 7TJ, UK (t 01603 592264; e a.johnston@uea.ac.uk)

Further reading

Charlson, R., Lovelock, J., Andreae, M. & Warren, S. (1987). Oceanic phytoplankton, atmospheric sulphur, cloud albedo and climate. *Nature* **326**, 655–661.

Curson, A.R.J., Rogers, R., Todd, J.D., Brearley, C.A. & Johnston, A.W.B. (2008). Molecular genetic analysis of a dimethylsulfoniopropionate lyase that liberates the climate-changing gas dimethylsulfide in several marine α-proteobacteria and *Rhodobacter sphaeroides*. *Environ Microbiol* **10**, 757–767.

Howard, E.C., Henriksen, J.R., Buchan, A. & others (2006). Bacterial taxa that limit sulfur flux from the ocean. *Science* **314**, 649–665.

Lovelock, J.E., Maggs, R.J. & Rasmussen, R.A. (1972). Atmospheric dimethyl sulphide and the natural sulphur cycle. *Nature* **237**, 452–453

Simó, R. (2001). Production of atmospheric sulfur by oceanic plankton: biogeochemical, ecological and evolutionary links. *Trends Ecol Evol* **16**, 287–294.

Stefels, J., Steinke, M., Turner, S., Malin, G. & Belviso, S. (2007). Environmental constraints on the production and removal of the climatically active gas dimethylsulphide (DMS) and implications for ecosystem modelling. *Biogeochemistry* **83**, 245–275.

Todd, J.D., Rogers, R., Li, Y.G. & others (2007). Structural and regulatory genes required to make the gas dimethyl sulfide in bacteria. *Science* **315**, 666–669.

Vallina, S.M. & Simó, R. (2007). Strong relationship between DMS and the solar radiation dose over the global surface ocean. *Science* **315**, 506–508.

NO laughing matter: the toxic gases of the nitrogen cycle

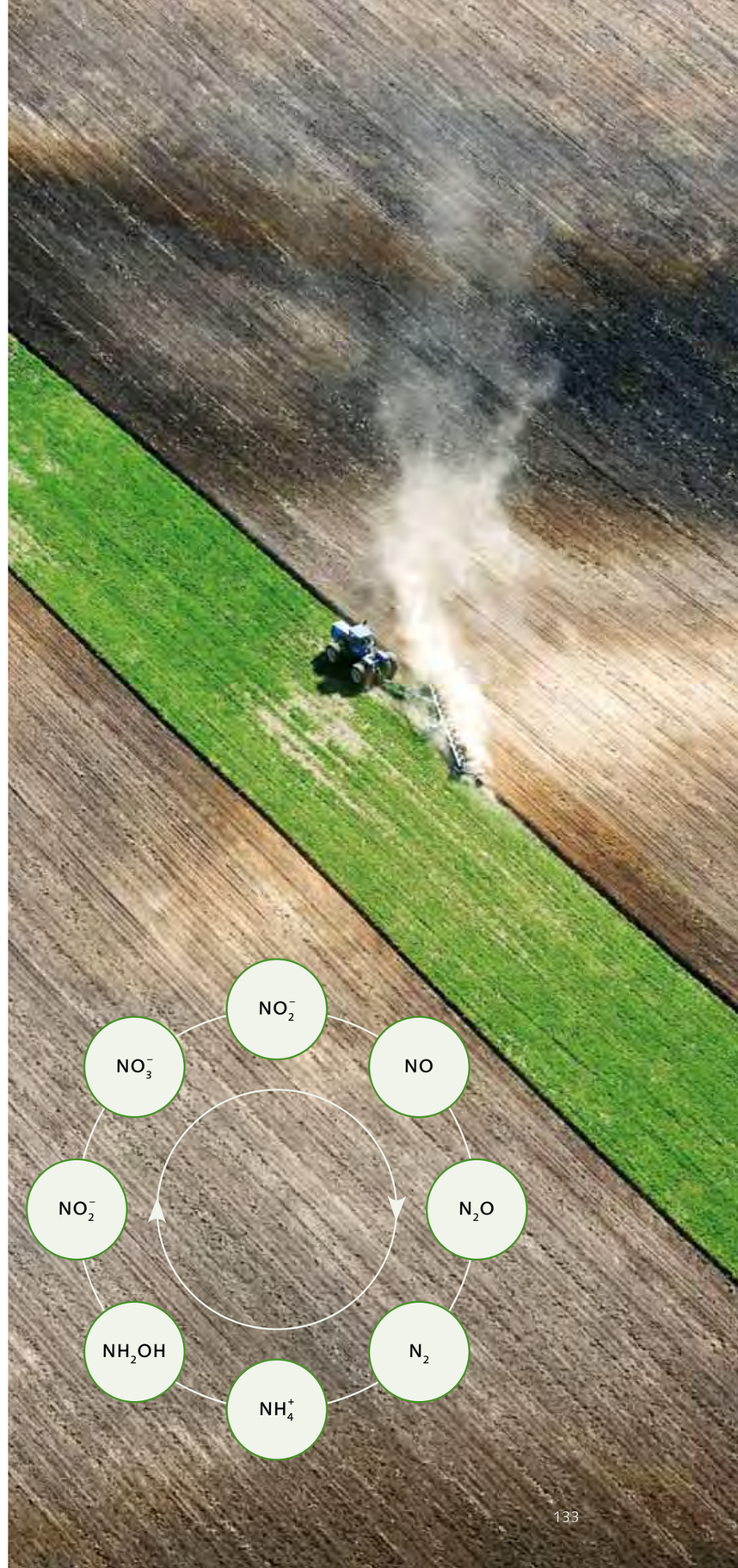
Nitric oxide (NO) is one of the most versatile and important molecules in living organisms but as **David J. Richardson**, **Andrew J. Thomson** and **Nicholas J. Watmough** describe, it is also a potent cytotoxin. Converting it to nitrous oxide renders it relatively harmless, but the resultant greenhouse gas causes different problems.

As humans we are dependent on oxygen for our respiration. We are obligate aerobes. This is not so for many species of bacteria. Faced with a shortage of oxygen in their environment many bacterial species are able to switch to using nitrate (NO_3^-), rather than oxygen to support respiration. One of these energy yielding processes, known as denitrification, converts water-soluble nitrates to gaseous products, nitric oxide (NO), nitrous oxide (N_2O) and dinitrogen (N_2). This denitrification process can take place extensively in agricultural soils where nitrogen-rich fertilizers added to stimulate plant growth can also stimulate bacterial nitrogen cycling (Fig. 1).

Destroying a cytotoxin, producing an environmental toxin

NO is one of the most versatile and important molecules in living organisms. In higher animals and plants it is an important signalling molecule, for example it is the effector responsible for stimulating the dilation of blood vessels. However, it is also a potent cytotoxin and specialized cells called macrophages produce NO as part of a generalized response to invasion by pathogenic bacteria. Such bacteria have evolved a number of enzymic systems to defend themselves against this 'gas attack'. Soil bacteria which can denitrify also need to protect themselves from the autotoxic effects of NO produced through their own metabolism. They have an enzyme, nitric oxide reductase (NOR) that has evolved to keep endogenous NO levels low by converting it to the relatively benign N_2O which can be released into the atmosphere. From the perspective of bacterial metabolism, the job of detoxifying cytoxic NO is done when it is converted to N_2O, but from an environmental perspective an envirotoxin, a greenhouse gas, has been produced. When discussing greenhouse gas emissions, the public are acutely aware of the problems posed by carbon dioxide and possibly methane. However, emissions of N_2O, perhaps best known as the dental anaesthetic 'laughing gas' should also cause concern.

N_2O was first discovered by the British chemist Joseph Priestley in 1793 and its effects on the human senses were famously explored by a number of notable scientists and poets of the time, such as Sir Humphrey Davy (President of the Royal Society 1820–1827) (Fig. 2) and Robert Southey (Poet Laureate, 1813) who both wrote about it:



▶ Fig. 1. The nitrogen cycle. *Background: Thinkstock Images / Jupiter Images*

Yet are my eyes with sparkling lustre fill'd
Yet is my mouth replete with murmuring sound
Yet are my limbs with inward transports fill'd
And clad with new-born mightiness around.

Sir Humphrey Davy

I am sure the air in heaven must be this wonder
working gas of delight

Robert Southey

When Joseph Priestley discovered N_2O, its atmospheric levels had been steady for millennia. However, throughout the 20th century (Fig. 3), and continuing into the 21st century, N_2O in the environment has increased by 50 parts per billion. The levels of this atmospheric loading are rising by 0.25 % each year, with most commentators linking the increase to intensive use of fertilizer to improve farmland productivity in the 20th century (Fig. 3). Although its atmospheric levels are only a fraction of that of CO_2, N_2O has a 300-fold greater global warming potential. Thus when expressed in terms of CO_2 equivalents, it represents around 9 % of total global emissions of greenhouse gases. With an atmospheric lifetime of some 150 years, the N_2O produced today will potentially influence the climate experienced by our great-great grandchildren. This is most definitely not a laughing matter and so it is important to predict the impact of N_2O emissions on environmental change and devise strategies to mitigate these releases now.

Understanding the denitrification enzymes that make and break N_2O

The pathways by which denitrifying bacteria produce NO from nitrate are now well understood from a molecular level, with the structures of enzymes that convert nitrate to nitrite (nitrate reductases) and nitrite to nitric oxide (nitrite reductases) being known. These enzymes are metalloproteins that depend on transition metals such as molybdenum, iron and copper for activity.

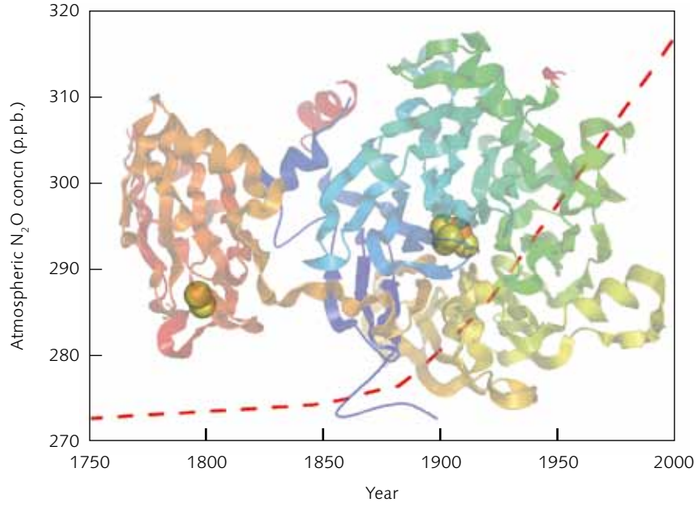
The molecular structure of the membrane-associated enzyme complex (NOR) that synthesizes N_2O in bacteria is not yet known. It is, however, a close relative of the enzyme in the mitochondria of human cells that allows us to respire oxygen. The chemical reaction takes place at a special dinuclear metal centre in the heart of the enzyme that binds two iron ions. In order to produce one molecule of N_2O, bacterial NOR requires not only two molecules of NO, but also two electrons and two protons (hydrogen ions) whose arrival at the enzyme's active site (which consists of two iron atoms) must be carefully co-ordinated. The enzyme that breaks down N_2O is a copper-containing enzyme (nitrous oxide reductase; N_2OR). It is the major enzyme on the planet responsible for catalysing the two-electron reduction of N_2O to N_2. Without it, the atmospheric levels of N_2O would be much greater than they currently are.

The molecular structure of N_2OR is known. It exists as a functional homodimer (one monomer is shown as the background to Fig. 3), that contains 12 atoms of copper with each subunit having two different types of copper clusters. The dinuclear cluster, known as CuA, serves to pass electrons to the active site which is known as CuZ, that breaks the N–O bond to make N_2 which is not a greenhouse gas. The correct assembly of CuZ, a tetranuclear copper sulfide centre, unique in biology, utilizes a dedicated biosynthetic pathway that is limited by the bioavailability of copper in the environment.

◀ Fig. 2. Sir Humphrey Davey and colleagues at the Royal Institution inhaling gases such as nitrous oxide as part of the science of pneumatics. Coloured etching by J. Gillray, 1802. *Wellcome Library, London*

How can we mitigate N_2O release?

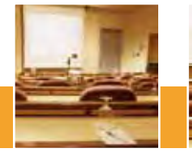
The largest source of anthropogenic N_2O emissions is agricultural soils because of the application of nitrogenous fertilizers to soils that began in the early 1900s and continues to increase today. This intensive use of fertilizers provides an interesting paradox for policy makers in that some strategies based on biofuel production designed to mitigate the effects of CO_2 release from fossil fuel actually lead to increases in global warming potential because of the increased requirement for artificial fertilizers. Since the UK signed up to the Kyoto Protocol, many non-biological sources of N_2O emissions have been reduced, but emissions from biological sources are less easy to manage. Efforts to improve the prediction and management of agricultural N_2O emissions will benefit from a better understanding of the factors that influence the net production of N_2O by bacteria. It is imperative that the outcomes of this research are translated into policy and practices through the development of appropriate management techniques for a range of soil systems that both mitigate emissions and improve existing agricultural and waste-treatment practices.



◀ Fig. 3. Atmospheric N_2O accumulation since 1750. *Data adapted from the 4th Assessment of the Intergovernmental Panel on Climate Change*. Background: Molecular model of nitrous oxide reductase (N_2OR) from *Paracoccus denitrificans* drawn using the co-ordinates 1FWX.

David J. Richardson,
Andrew J. Thomson &
Nicholas J. Watmough
The authors are all members of a new Nitrous Oxide Focus Group (www.nitrousoxide.org) that brings together scientists from a range of disciplines with various stakeholders with the aim of sharing knowledge on nitrous oxide and exploring strategies for mitigating release. University of East Anglia, Norwich NR4 7TJ, UK (e d.richardson@uea.ac.uk; a.thomson@uea.ac.uk; n.watmough@uea.ac.uk)

meetings



Autumn**08** | Trinity College Dublin

8–11 September 2008 | 163rd Meeting

Plenary

Behaviour of biofilm bacteria: from cooperation and communication to control

8–9 September 2008

Organizers: G.M. Gadd, P.S. Handley, P.R. Langford, H.M. Lappin-Scott, M.M. Tunney, M. Upton & J. Verran

Programme Booklet

A booklet giving full details of the programme is enclosed with this issue of *Microbiology Today*. Any changes will be posted on the SGM website.

Special Events

Monday 8 September
Welcome Reception

Get to know your fellow delegates over a glass of wine on the first evening of the conference. Venue: Trinity College Dublin.

Tuesday 9 September
Society Dinner

A four-course meal with inclusive wine and pre-dinner drink will take place at the Guinness Storehouse, St James's Gate, Dublin.

Registration

Registration is through the SGM website (www.sgm.ac.uk/meetings). Anyone experiencing problems registering on the website should contact the Meetings Office.

Registration fees per day (*incl. refreshments, conference literature, welcome reception*)

Earlybird (up to 8 August 2008)

Ordinary Members*	£40
Student/Associate Members*	£20
Non-members	£110
Retired/Honorary Members*	Free

Full (after 8 August 2008)

Ordinary Members*	£50
Student/Associate Members*	£30
Non-members	£120
Retired/Honorary Members*	£10

Please note: to qualify for earlybird rates, 2008 membership fees must be paid by the deadline of **8 August.*

Accommodation

For this event, o/n accommodation is not available through the Society and delegates must make their own arrangements. Conference Partners offer an online booking service: www.conferencepartners.ie/sgm2008/
t +353 (0)1 296 8688
e lisa@conferencepartners.ie

Postgraduate Conference Grants

For full details, see **www.sgm.ac.uk/grants/pg.cfm**

Offered Poster Presentations

Delegates whose offered posters have been accepted should note that an area of 90x90 cm only is available on the poster boards for their display.

Microscene Noticeboard

At the meeting, a board will be set up with notices of jobs, postdoctoral positions, studentships, courses, conferences, etc. Contributions are welcome and may be either brought to the meeting or sent beforehand to Janet Hurst (e j.hurst@sgm.ac.uk).

Spring**09** | Harrogate International Centre

30 March–2 April 2009

Legacy of Fleming – 80 years since the discovery of penicillin

From 2009, Society meetings will have a new look. The scientific sessions over three and a half days will cover the latest topics in modern microbiology, within a framework of fewer parallel sessions in the mornings, stand-alone keynote lectures and afternoons packed with workshops, debates, demonstrations and mini-symposia catering for all areas of microbiological science.

Poster-viewing will take place over a drink in the evenings.

Career development and microbiology education will also be covered. The ever-popular Gala Dinner will retain its Tuesday evening slot.

The first conference under the new system will take place at Harrogate International Centre. This is an excellent venue, with a range of high-specification lecture theatres, a large exhibition hall and plenty of space for poster boards and networking. Accommodation to suit all tastes and pockets is available in the town.

Programme

The Legacy of Fleming

This is the main theme of the meeting. 80 years after Alexander Fleming discovered penicillin, our scientific sessions will consider the latest developments in the diagnosis, prevention, control and treatment of infectious diseases. Topics include:

Impact of medical intervention on evolution of microbes / Multi-drug resistant TB / Production, formulation and delivery of antimicrobials / New antibiotics / Infection control / Novel therapeutics / Susceptibility to infection and disease / Mechanisms of resistance / Antibiotic resistance in staphylococci / Bedside diagnostics / Molecular evolution of virus pathogens.

Related events

Lessons in history: the microbiology of war wounds

The human microbiota

Other sessions:

Molecular virology

Environmental microbiology

Metagenomics

Food preservation

PLUS 6 virology workshops on a range of subjects.

Prize Lectures

The new SGM Prize Medal

Colworth Prize

Fleming Award

Careers and education events

University Challenge: the transition from school to university

Careers in clinical microbiology

Careers planning for postgrads

Careers drop-in for postdocs

SGM plant virologists will also be holding a joint one-day meeting with the Association for Applied Biology.

Other**Events**

Biochemical Society/SGM

Molecular biology of *Archaea*

St Andrews – 19–21 August 2008
www.biochemistry.org/meetings/programme.cfm?Meeting_No=SA079

Federation of Infection Societies Conference

Cardiff City Hall
2–4 December 2008
www.fis2008.co.uk

Recent Independent Virology Researchers' (RIVR) Meeting

Breadsall Priory Hotel, near Derby

5–6 January 2009

For further details, contact Alain Kohl (Alain.Kohl@ed.ac.uk) or Chris McCormick (cjm@soton.ac.uk)

Meetings on the web

For up-to-date information on future Society meetings and to book online see **www.sgm.ac.uk**

Meetings organization

The organization of SGM meetings programmes is co-ordinated by the Scientific Meetings Officer, **Professor Hilary Lappin-Scott**, and Deputy Scientific Meetings Officer, **Professor Chris J. Hewitt**. Suggestions for topics for future symposia are always welcome.

Administration of meetings is carried out by **Mrs Josiane Dunn** at SGM Headquarters, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG (t 0118 988 1805; f 0118 988 5656; e meetings@sgm.ac.uk).

Abstracts

Titles and abstracts for all presentations are required in a standard format and should be submitted through the SGM website. Deadlines for submissions are published in *Microbiology Today* and on the web. For further information contact the Events Administrator.

Irish**Division**

23–24 April 2009

Innovative models and systems for studying microbial pathogenesis

University of Cork, Ireland

For further details, contact John Morrissey (e j.morrissey@ucc.ie).

For details of other Irish Division activities, contact Evelyn Doyle (e evelyn.doyle@ucd.ie)

Schools Membership costs only £10 a year. Benefits include *Microbiology Today*, advance copies of new teaching resources and discounted fees on SGM INSET courses. To join see **www.sgm.ac.uk/membership**. Enquiries: **education@sgm.ac.uk** or go to **www.microbiologyonline.org.uk** for full details of resources and activities.

Epidemics following natural disasters

Misconceptions reported in the media may distort the science behind a story – so students should look to primary sources for the real facts. **Dariel Burdass** asks if people are more at risk from the living or the dead?

Following a natural disaster, such as the tsunami on 26 December 2004, which overwhelmed much of Indonesia, and the cyclone, which devastated Myanmar (Burma) on 3 May 2008, reports in the media often overstate the risk of epidemics of highly infectious diseases such as cholera, hepatitis and typhoid. This is mainly due to the fear associated with the presence of numerous dead bodies in an affected area. However, evidence has shown that disease outbreaks following a natural disaster are a rare occurrence and that a dead body decomposing either on the land or floating in the floods is unlikely to cause an epidemic. Survivors with diseases (Table 1) are a far greater hazard to health than the dead.

Deaths following natural disasters are usually due to blunt trauma, crush-related injuries or drowning, not communicable diseases. For an infection to be successfully transmitted from person to person, three factors are necessary:

- The presence of an infectious agent e.g. in the case of cholera, the bacterium *Vibrio cholerae*
- Exposure to that agent
- A susceptible host (human), e.g. someone with underlying poor nutritional levels, as malnutrition increases the risk of death from communicable diseases.

A person killed in a natural disaster through trauma, etc., is no more likely than any other person from the local population to have a communicable disease. So unless they were carrying an infectious agent when they died, their bodies do not pose a risk to human health. Micro-organisms associated with the decay of the human body (the decomposers) are not usually human pathogens.

Table 1. **Micro-organisms most commonly linked by the media and some health officials with transmission from dead bodies**

Mode of transmission	Micro-organism	Disease
Gastrointestinal tract	*Salmonella typhi*	Typhoid
	Shigella sonnei	Dysentery
	Vibrio cholerae	Cholera
Blood-borne	Hepatitis B and C	Hepatitis
	HIV	AIDS
Air-borne	*Mycobacterium tuberculosis*	TB
Vector-borne	*Plasmodium* spp.	Malaria

Persistence

When the host dies, pathogens usually have limited viability, as they cannot sustain their growth alone. Consequently, they are unable to survive for long in the surrounding environment and present little infectious risk. The ability of a micro-organism to survive outside the human body is called its persistence. For all pathogens, survival is dependent on a range of factors, including temperature; microbes will persist for longer at lower temperatures. However, because pathogens do not die immediately after their host does, transmission from a dead body to a living person is still possible, but those most likely to be at risk are not the general population but relief workers who can minimize their exposure to potential pathogens by following basic hygiene rules such as hand washing and using appropriate protective equipment such as gloves.

Transmission

The factors which influence the transmission of infectious diseases from person to person after a natural disaster are

- the size of the displaced population
- access to clean water
- sewage facilities
- health status of the population
- whether a disease is endemic locally

The peak danger period for transmission is between 10 days and a month after a natural disaster as this is usually when water, hygiene and sewage facilities are at their poorest and levels of overcrowding are particularly high due to population displacement. For example, if a survivor carrying *V. cholerae* is housed in an overcrowded facility with poor or no toilet facilities and the sewage is leaking into the drinking wells, then the microbe could spread rapidly through the population via the faecal–oral route.

Fact versus fiction

In 2004, there were no serious epidemics and no cases of cholera reported to the WHO or other health surveillance bodies in the 4 months after the tsunami, even though more than 175,000 people died. Several factors may have been responsible:

- cholera occurs in Indonesia between March and September and the tsunami hit in December
- the displaced population was housed in small camps compared with the large overcrowded settlements often used to house conflict- or disaster-associated people.
- adequate drinking and washing water were supplied to the camps.

> *'Access to clean water and sanitation remains a major health challenge in Myanmar.'* *WHO, 4 June 2008*

The real risk of an epidemic in Myanmar

According to WHO medical epidemiologist, Dr John Watson, Myanmar is at higher than usual risk of a communicable disease because at least a quarter of a million people have been displaced, coupled with serious overcrowding. Also the underlying nutritional levels in the country are poor and there is very limited access to health services. With respect to gastrointestinal infections such as cholera, approximately 75 % of people in Myanmar have no toilets and defecate outside. As the water levels are so high, this excrement is contaminating water supplies, putting those displaced at greater risk. Appropriate disposal of human faecal matter can reduce diarrhoea by 40 %. It is also the cholera season in Myanmar and cholera is endemic in the Irrawaddy delta. So in this area the dangers of a cholera epidemic are real.

The online version of this article has links to a number of useful websites: **www.sgm.ac.uk/pubs/micro_today**

◀ Cyclone-affected families living in temporary accommodation near Yangon, Myanmar, on 25 May 2008. *Khin Maung Win / AFP / Getty Images*

Bioscience Outreach in Schools Colloquium

Tuesday, 28 October 2008 – National Science Learning Centre, York

The Biosciences Federation Education Committee (chaired by Sue Assinder, SGM Education Officer) is organizing this Colloquium in partnership with the National Science Learning Centre. It will aim to bring together school biology teachers with deliverers of outreach (e.g. learned societies, academics and industry) to discuss effective practice and make recommendations on how activities within the biosciences might be co-ordinated. Professor John Holman (National STEM Director) has agreed to give a keynote talk.

In addition to showcasing the outreach opportunities available, the Colloquium will explore strategic questions about outreach provision and result in publication of a formal stakeholder report. The Colloquium will be preceded on the previous afternoon by a professional development event for A level biology teachers. The SGM is providing financial sponsorship to the Colloquium and Janet Hurst and Dariel Burdass are playing a major role in organizing the event. Registration details are available on the Biosciences Federation website (www.bsf.ac.uk).

Antibiotic resistance challenge – poster competition

Key Stage 3 Science students are invited to enter an exciting poster competition. Their eye-catching poster should aim to encourage friends and family not to go to the GP for antibiotics for coughs and colds as these do not work on such virus infections. It is important that people understand when they should use antibiotics and when it is not appropriate.

In the UK, the Department of Health's Advisory Committee for Antimicrobial Resistance and Healthcare Associated Infection is holding a national conference to mark European Antibiotic Awareness Day which will take place on 18 November at the Science Museum, South Kensington, London. The target audience will be health/science journalists and health professionals. The winning poster will be printed to coincide with the day and displayed at the conference.

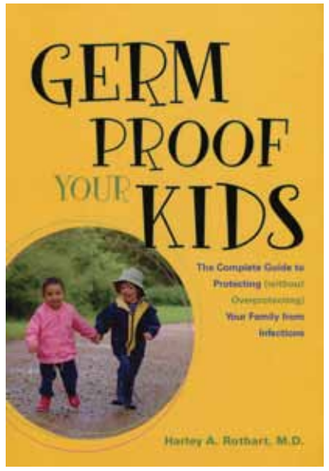
Prizes include an *iPod Nano* for the winner and £1,000 worth of science equipment for the school, which will be presented at the conference. The winning school will also be invited to visit a microbiology laboratory. Three runners up will receive £25 entertainment vouchers and £100 worth of science equipment for the school.

Information on how to enter is available at **www.nhs.uk/arc** and includes teachers' notes, lesson plans, key facts, the competition rules and entry form. Closing date for entries is **10 October 2008**.

Germ Proof Your Kids:

The Complete Guide to Protecting (without Overprotecting) Your Family from Infections

By H.A. Rotbart
Published by the American Society for Microbiology (2008)
ISBN 978-1-55581-427-4



As the healthy daughter of parents who firmly believe in the hygiene hypothesis and think sawdust and soil are perfect additions to a toddler's diet, I was initially sceptical about this book. In fact, I was looking forward to writing a scathing review. But I should have paid more attention to the *without overprotecting* caveat: this book is excellent and deserves a place on every parent's bookshelf and would be a useful addition to any school library.

The first chapter, 'Worthy Enemies', is an introduction to pathogens and their transmission. Rotbart also provides a glossary of infections that includes the most common childhood ailments plus those that children are unlikely to contract but are parents' greatest fear. The profiles of diseases, such as measles and polio, which are 'so last generation' remind readers of the importance of vaccination and the consequences of complacency.

In 'Weapons in War', the author explains the basics of immunology, the science of vaccination and the treatment of infections. He provides clear explanations, with easy-to-understand analogies, of concepts that can be difficult to grasp. The section on vaccination provides detailed information about specific vaccines and a balanced discussion of parental concerns and recent controversies. The section about the use and misuse of antibiotics is informative.

'Wear Your Boots in the Rain' is a guide to personal, domestic and community hygiene, nutrition and the reality behind 'miscellaneous momisms'. These include: chicken soup (it tastes nice, nothing more), sleep (yes, you need it), stress (too much depresses the immune system) getting cold and catching one (the jury is still out) and exercise (regular exercise good, extreme exercise bad).

The final chapter 'The Wisdom of Ages' offers guidance in dealing with what is described as the continuous onslaught of newspaper fear factors. His advice is to respond with prudence, not paranoia and the 'good sense to recognize the nonsense'. So, when running late on a Monday morning, I will continue to leave the house with wet hair; but I will be washing (and drying) my hands as frequently as Lady Macbeth and discarding my dish cloths daily. I will ensure my children are up-to-date with their vaccinations and I won't be asking the doctor for antibiotics to treat a cold.

The book is scientifically accurate and up-to-date. As a reference book it is a reliable resource that is easy to navigate. As bedtime reading, its mixture of humour and common sense make it an enjoyable read. Rotbart manages to correct misconceptions and debunk myths while sensitively dealing with contentious issues and parental anxiety. It is an antidote to all the rubbish science that we are too often bombarded with. I would highly recommend it.

***Gemma Sims**, SGM*

Professor Norbert Pfennig

(08.07.**1925**–11.02.**2008**)

Norbert Pfennig, former professor of limnology and microbial ecology at the University of Konstanz, Germany, has died, aged 82. Born in 1925, he studied biology in Göttingen and soon concentrated on microbiology under the guidance of August Rippel-Baldes. In 1952, he obtained his doctoral degree in organic chemistry under Hans Brockmann. He became an adjunct professor of microbiology in Göttingen in 1964 and later the head of a research group for nutritional physiology of micro-organisms.

When Hans Schlegel joined the Göttingen Institute for Microbiology in 1959 and brought along water samples from a pond with obvious development of purple phototrophic sulfur bacteria, Norbert decided to try to cultivate them. Within 2 years, he had explored the growth demands and invented a specific technique employing defined media to further enrich and finally isolate these barely cultivable, fastidious bacteria.

A research visit with Cornelis van Niel at Pacific Grove, California, deepened his interest in phototrophs, and he remained an admirer of van Niel as a researcher and teacher. After the discovery of the importance of vitamin B12 for the cultivation of phototrophs, a broad range of these bacteria was isolated in pure culture and characterized in depth. From his days in van Niel's lab, co-operations arose with Germaine Cohen-Bazire and Roger Stanier, leading to detailed electron microscopic studies of the intracellular membrane arrangement and the discovery of the *Chlorobium* vesicles. The following years were filled with numerous studies of phototrophs and their taxonomic organization, to which his first postdoc, Hans Trüper, contributed, and he served *Bergey's Manual* as a Trustee for many years.

New research fields opened up during a study of green phototrophs. From an enrichment culture of *Chlorobium*-like phototrophs on ethanol, the first pure cultures of ethanol- and acetate-oxidizing sulfur reducers were obtained (with Hanno Biebl), along with the discovery of a syntrophic co-operation through a sulfur/sulfide cycle. These and numerous sulfate reducers (with Friedrich Widdel) were also the basis for a long-lasting friendship with Rudolf Thauer who studied the biochemistry of these novel bacteria.

In 1979, Norbert accepted a professorship at the University of Konstanz until his retirement in 1990. As a scientist always searching for holistic explanations, he saw the micro-organism not only as a cell or strain with metabolic capabilities, but also as part of the ecosystem with its specific challenges, including limiting substrate supply, light of varying intensity and quality, and metabolic exchange with partner organisms. Inspired by this philosophy and his new position, he entered a new phase in his career, extending his research on the interaction of microbes with their natural environment. Lake Konstanz and small lakes and ditches in the area became the objects of research and teaching, with a focus on the activities of anaerobic bacteria, especially the phototrophs, the sulfate reducers and syntrophic methanogenic co-cultures.

Unlike many traditional professors, he gave an enormous amount of freedom to his scientists and acted more like a colleague, always curious to exchange news. His lectures and courses were characterized by a similar attitude; he did not regard himself as someone who simply had to transfer knowledge, but to convey the attitude of asking questions, always willing to learn from the microbes. He enjoyed discoveries like any graduate student, even the small breakthroughs, and used to express this by his unconstrained laughter.

He was awarded the Research Prize of the Deutsche Gesellschaft für Hygiene und Mikrobiologie in 1980, he was a corresponding member of the Academy of Sciences in Göttingen, and an honorary member of the SGM and the Vereinigung für Allgemeine und Angewandte Mikrobiologie in Germany. He was awarded the Bergey Medal in 1992 and received an Honory Doctoral Degree from the University of Bonn.

The microbiological community in Germany and abroad has lost one of its most prominent members and founding fathers, one of the last representatives of a general microbiology based on a specific feeling for the microbes' capabilities and demands from the ecological perspective. Several of his discoveries changed and extended our understanding of the action of microbes in nature. Those closer to him lost a personal friend of unusual modesty, an honourable personality with an open mind. Our sympathy is with his wife Helga, five children and nine grandchildren.

Friedrich Widdel, Bremen; **Bernhard Schink**, Konstanz

Gradline aims to inform and entertain members in the early stages of their career in microbiology. If you have any news or stories, or would like to see any topics featured, contact **Jane Westwell** (e j.westwell@sgm.ac.uk).

Getting funding to become a successful independent researcher is tricky, but it can be done, as **Jane Westwell** describes.

Funding your research

Stepping stones

Microbiologists planning a career in research very often follow their PhD studentship with a spell as a postdoc, employed on one or more short-term contracts. The funding is sought by the principal investigator who usually maintains an overview of the project's direction. Postdocs on this type of contract can build up a good portfolio of laboratory skills but, for those aiming at a long-term research career, it is necessary to develop as an independent researcher. One of the stages on that journey to independence is getting funds to support your own research ideas.

The problem for most postdocs seeking to establish themselves is a lack of track-record, but there are ways around this. Some researchers take the opportunity to develop their own ideas whilst still fulfilling the obligations of their contract. They then work up an idea for a new project with their principal investigator (PI) who submits a grant application to a funding body. This type of grant is awarded under the response mode – funding bodies outline their research priorities and scientists submit applications within the relevant remit. Committees meet a few times each year to consider the proposals. Grants are usually for 2–3 years and include staff salary costs and associated research expenses. This approach can offer postdocs the opportunity to develop skills in writing a good proposal, but because the application must be made by the established researcher (the PI) it isn't a fast route to recognition as an independent scientist. However, some funding bodies do accept applications made jointly by experienced postdoctoral researchers with a principal applicant who has been in a permanent post for at least 5 years. It is worth bearing in mind that the success rate for response mode grant applications to the Research Councils can be lower than 30%, so even the most carefully targeted grant application may not always meet with success.

Industrially funded researchers may spot a good opportunity for further funding and develop a project proposal, with their PI, which they pitch to the sponsor. This would probably involve developing a good written proposal followed by meetings to discuss the work to ensure it matches the sponsor's requirements (as well as offering the postdoc the chance to do some publishable research).

The direct approach

There are a number of schemes to support early-career scientists who wish to strike out on their own. Funding bodies do want to support talented early-career researchers and can offer financial support at this crucial stage. Eligibility criteria (such as EU or UK citizenship) for these awards can be a factor, so it is worth checking carefully before starting the application process.

Microbiologists whose research is rooted in the biomedical sciences can apply to the Wellcome Trust and Medical Research Council (MRC) for support. Newly qualified postdocs can apply for a Sir Henry Wellcome Postdoctoral Fellowship. Applicants are expected to identify an important biomedical research question and develop a research programme. The fellowship is 4 years full-time, but may be taken up on a part-time basis with the tenure of award lengthened accordingly. Biomedical researchers with 3–6 years postdoc experience can apply to the Wellcome Trust for a Postdoctoral Fellowship or to the MRC for a Career Development Award. Both schemes cover the applicant's salary, research expenses and sometimes the cost of employing support staff.

The BBSRC offers up to 10 David Phillips Fellowships each year to scientists with 2–6 years postdoctoral experience who want to establish themselves as independent researchers. They also offer Institute Career Path Fellowships to early-career researchers wishing to work in a BBSRC institute in areas of high strategic importance to the research council. These fellowships are targeted to different institutes and different areas of science each year. Both schemes award a salary for 5 years and a significant grant towards research costs.

The Natural Environment Research Council (NERC) makes about 30 3-year Postdoctoral Research Fellowships each year, aiming to support outstanding environmental scientists as they become independent. Although applicants are usually expected to have at least 1 year of postdoctoral experience, some grants are made to candidates before they are awarded their PhD. Postdocs with at least 2 years of experience who can prove their ability as independent researchers can apply for an Advanced Fellowship. NERC fellowships are open to any nationality.

Mid-career postdocs (with 1–3 contracts behind them) can apply to the Royal Society's University Research Fellowships scheme. The fellowships last for 5 years with the possibility of a further 3 years of funding. At the end of the fellowships, it is expected that candidates would be in a strong position to obtain permanent university posts.

The Leverhulme Trust offers Early Career Fellowships to scientists with a proven record in research. Applications are accepted in any discipline, and in 2008 they expect to award 55 fellowships which can be held at any UK university or research institution. The fellowships are for 2 years and include 50% of total annual salary costs and up to £5,000 a year to support research costs. The host institution is expected to make up the salary shortfall and it is anticipated that the fellowship will lead to a permanent position.

Returning to research

The Daphne Jackson Trust provides university and industrial fellowships to help scientists who have had a career break of more than 2 years. Applicants must have completed their PhD before the career break started. The fellowships are usually of 2 years duration, are carried out flexibly and involve an element of retraining and updating of skills. Projects can be hosted by university departments or by research divisions of industrial establishments.

The Wellcome Trust runs a similar scheme for researchers in the biomedical sciences. Their Career Re-entry Fellowships are tenable for 2–4 years and may be taken up on a full or part-time basis.

Flexible approach

For those who require an element of flexibility in balancing their work and home commitments, the Royal Society administers the Dorothy Hodgkin Fellowships. Women are particularly encouraged to apply to the scheme which is designed to help successful candidates progress to permanent academic positions in the UK. A useful feature is that successful fellows can work on a full- or part-time basis or even convert from one to the other, depending on personal circumstances. Applicants have usually completed one or two postdoctoral contracts, although it is possible to apply to the scheme after completion of a PhD project.

Some of the other fellowships outlined earlier can also be awarded to scientists wanting to work on a part-time basis (usually for a minimum of 50% full-time hours). It is worth checking the fellowship handbooks (published on the funding bodies' websites) for full details.

International perspective

Some fellowship opportunities are funded by the EU Marie Curie Actions scheme. Grants allow early-stage researchers to spend a period of 1–2 years in a host laboratory. This funding is viewed as a training grant, so must form part of a long-term plan for professional development. Marie Curie Intra-European Fellowships support travel to labs within the European Union. International Outgoing Fellowships for Career Development support travel by European researchers to a laboratory outside of Europe. Conversely, International Incoming Fellowships support researchers from outside Europe to work on research projects in an EU member state with a view to developing collaborations between that country and the researcher's home country. Grants include a monthly living allowance, travel and limited research costs.

The Newton International Fellowships scheme was launched this spring. The scheme is run by a group of organizations, including Research Councils UK and the Royal Society. It funds promising early-career scientists from any country outside the UK who want to carry out work at a UK research institution for up to 2 years. The awards provide a substantial contribution towards subsistence and research expenses, plus a one-off relocation allowance. The long-term aim is to encourage new international collaborations and a feature of the grant is a 10-year follow-up package, for those who remain in research, to support activities that maintain links with the UK.

Getting an award

Competition for these funding schemes is strong and the majority look for researchers with potential to be leaders in their chosen field. If you are thinking of applying for any of these grants, give yourself plenty of time, target the application very carefully, and it is a good idea to find a mentor who will support you during and after the application process.

Further information

cordis.europa.eu
www.daphnejackson.org.uk
www.nerc.ac.uk
royalsociety.org
www.bbsrc.ac.uk
www.mrc.ac.uk
www.newtonfellowships.org
www.wellcome.ac.uk

Working towards a career in university research & teaching

Gail Ferguson is a senior lecturer at University of Aberdeen. She shared her experience with early-career microbiologists at the Spring Meeting this year.

Profile

Name Gail Ferguson Age 38
Present occupation Senior Lecturer, School of Medicine, University of Aberdeen
Previous employment Lecturer in Biological Sciences, University of Edinburgh (Sept 2004–May 2007); Postdoctoral Associate, Massachusetts Institute of Technology (Oct 1999–Sept 2004); Wellcome Trust Postdoctoral Toxicology Fellowship, University of Aberdeen (Oct 1996–Sept 1999); Postdoctoral Associate, University of Aberdeen (Jan 1994–Oct 1996).
Education University of Aberdeen, *PhD Microbiology*; University of Stirling, *BSc Biochemistry Hons (2i)*.

What attracted you to microbiology research?

I became fascinated with microbiology during my undergraduate degree, during which I conducted two summer projects and an honours project on trichomonads. From this experience, I knew that I wanted to pursue a research career. I would thoroughly encourage undergraduates to gain research experience as this can ensure that you choose a PhD in an area that interests you.

What influenced your decision to work as a postdoc in the USA?

After my Wellcome postdoc fellowship I had to make a decision whether or not to apply for lectureships. However, since my research experience had mostly focussed on *E. coli*, I wanted to gain further experience in more diverse bacterial species before taking up a permanent position. I went to work in the USA at MIT, due to its reputation and that of the 'Boston Bacterial' community. I chose to go to Graham Walker's lab as I was really interested in his work on *Sinorhizobium* and *Brucella*.

How did this compare with your previous postdoctoral experience?

When I arrived in the USA I was given a bench and just had to get on with it. Graham was fantastic in terms of the 'big picture', which was exactly what I needed in terms of my career at that stage. However, I would recommend that people do at least one postdoc before going to the USA where more is expected of postdocs since the PhD there is longer (5–7 years).The work ethic is a bit different in the USA. Most people arrived in the lab around 10 am and worked until 8–10 pm, yet Graham did not micromanage and was more interested in progress. He was also very happy to allow people to take holidays and wasn't strict about this as long as people worked hard. He was a very positive role model, managing to balance work and life and still be extremely successful.

How did you find the transition to an academic post in the UK?

It was a bit of a shock. I went from being in a lab with plenty of money to an empty lab with very little money. I had to go back to basics – filling tip boxes and pouring my own gels! However, there are many funding opportunities in the UK for new investigators and I was lucky to be awarded several grants. It has taken a while to get re-involved with the UK and European microbiology community, but I very much enjoy the UK system and am happy to be back.

How do you see your future?

I would like to continue in academia and build my research group. I enjoy the university environment and the balance between research and teaching.

What advice can you offer people planning a career as an academic?

During your postdoc, aim to develop the skills for running your own lab:

- Gain experience in writing and reviewing papers and grants
- Develop projects that you can take with you to your own lab
- Apply for fellowships (and check deadlines!)
- Make sure that you get a wide range of experiences during your postdocs (courses, work on different microbial systems and in different labs)
- Publish your research regularly and try to aim for high-quality journals
- Help in the supervision of student projects
- Do some teaching but do not take on too much – at the end of the day, its your research record that will get you the position
- Have a mock interview for fellowships or academic positions as it's important to know the types of questions you may be asked.

council07–08

Officers

President – Prof. Robin Weiss
Division of Infection and Immunity, University College London, 46 Cleveland Street, London W1T 4JF
t 0207 679 9554; **f** 0207 679 9555; **e** r.weiss@ucl.ac.uk

Treasurer – Prof. Colin R. Harwood
School of Cell and Molecular Biosciences, University of Newcastle Medical School, Framlington Place, Newcastle upon Tyne NE2 4HH
t 0191 222 7708; **f** 0191 222 7736; **e** colin.harwood@ncl.ac.uk

General Secretary – Dr Ulrich Desselberger
Dept of Medicine, University of Cambridge, Level 5, Addenbrooke's Hospital, Cambridge CB2 2QQ
t 01223 763403; **e** ud207@medschl.cam.ac.uk *or* udesselberger@btinternet.com

Scientific Meetings Officer – Prof. Hilary M. Lappin-Scott
Dept of Biosciences, University of Exeter, Geoffrey Pope Building, Exeter EX4 4QD
f 01392 263434; **e** h.m.lappin-scott@exeter.ac.uk

International Secretary – Prof. George P. C. Salmond
Dept of Biochemistry, University of Cambridge, Tennis Court Road, Building O, Downing Site, Cambridge CB2 1QW
t 01223 333650; **f** 01223 766108; **e** gpcs@mole.bio.cam.ac.uk

Education Officer – Dr Susan J. Assinder
Director of Education, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA

Editor, *Microbiology Today* – Dr Matt Hutchings
School of Biological Sciences, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ
t 01603 592257; **e** m.hutchings@uea.ac.uk

Editor-in-Chief, *Microbiology* – Prof. Charles J. Dorman
Dept of Microbiology, Moyne Institute, Trinity College, Dublin 2, Ireland
t +353 1 608 2013; **f** +353 1 679 9294; **e** cjdorman@tcd.ie

Editor-in-Chief, *JGV* – Prof. Richard M. Elliott
Centre for Biomolecular Sciences, School of Biology, University of St Andrews, North Haugh, St Andrews, Fife KY16 9ST
t 01334 463396; **e** rmel@st-andrews.ac.uk

Editor-in-Chief, *JMM* – Prof. Charles W. Penn
School of Biosciences, University of Birmingham, Edgbaston, Birmingham B15 2TT
t 0121 414 6562; **f** 0121 414 5925; **e** c.w.penn@bham.ac.uk

Members

Prof. Mike R. Barer
Infection, Immunity and Inflammation, University of Leicester, Medical Sciences Building, PO Box 138, University Road, Leicester LE2 4FF
t 0116 252 2933; **f** 0116 252 5030; **e** mrb19@le.ac.uk

Dr David J. Blackbourn
University of Birmingham, Cancer Research UK Institute for Cancer Studies, Edgbaston, Birmingham B15 2TT
t 0121 415 8804; **f** 0121 414 4486; **e** d.j.blackbourn@bham.ac.uk

Prof. Neil A. R. Gow
School of Medical Sciences, Institute of Medical Sciences, University of Aberdeen, Aberdeen AB25 2ZD
t 01224 555879; **f** 01224 555844; **e** n.gow@abdn.ac.uk

Dr Richard M. Hall
Biological Reagents and Assay Development (BR&AD), GlaxoSmithKline R&D, New Frontiers Science Park – North Site SC1, H31/1-047 (Mail Code H31111), Third Avenue, Harlow, Essex CM19 5AW
t 0127 962 7172; **f** 0127 962 7014; **e** richard.m.hall@gsk.com

Dr Kim R. Hardie
University of Nottingham, Centre for Biomolecular Sciences, University Park, Nottingham NG7 2RD
t 0115 846 7958; **f** 0115 586 7950; **e** kim.hardie@nottingham.ac.uk

Dr Paul A. Hoskisson
Strathclyde Institute of Pharmacy & Biomedical Sciences, University of Strathclyde, 204 Geroge Street, Glasgow G1 1XW
t 0141 548 2819; **e** paul.hoskisson@strath.ac.uk

Dr Catherine O'Reilly
Dept of Chemical and Life Sciences, Waterford Institute of Technology, Cork Road, Waterford, Ireland
t +353 51 302858; **f** +353 51 378292; **e** coreilly@wit.ie

Prof. Petra C. F. Oyston
TL Molecular Bacteriology, Dstl, B07A Microbiology, Porton Down, Salisbury SP4 0JQ
t 01980 613641; **f** 01980 614307; **e** pcoyston@dstl.gov.uk

Prof. Bert K. Rima
School of Biology and Biochemistry, Medical Biology Centre, The Queen's University of Belfast, 97 Lisburn Road, Belfast BT9 7BL
t 028 9097 5858; **f** 028 9097 5877; **e** b.rima@qub.ac.uk

groupconveners

Cells & Cell Surfaces – Dr Ian R. Henderson
Division of Immunity and Infection, University of Birmingham Medical School, Edgbaston, Birmingham B15 2TT
t 0121 414 4368; **f** 0121 414 3599; **e** i.r.henderson@bham.ac.uk

Clinical Microbiology – Prof. Dlawer Ala'Aldeen
Molecular Bacteriology and Immunology Group, Division of Microbiology, School of Molecular Medical Sciences, University Hospital, Nottingham NG7 2UH
t 0115 823 0748/0771 (secretary); **f** 0115 823 0759; **e** daa@nottingham.ac.uk

Clinical Virology – Prof. Judy Breuer
ICMS Centre for Infectious Disease, Barts and the London Medical School, 4 Newark Street, London E1 2AT
t 0207 882 2308; **f** 0207 882 2181; **e** j.breuer@qmul.ac.uk

Education & Training – Prof. Joanna Verran
Dept of Biology, Chemistry and Health Science, Manchester Metropolitan University, Chester Street, Manchester M1 5GD
t 0161 247 1206; **f** 0161 247 6325; **e** j.verran@mmu.ac.uk

Environmental Microbiology – Prof. Geoffrey M. Gadd
Division of Environmental and Applied Biology, Biological Sciences Institute, School of Life Sciences, University of Dundee, Dundee DD1 4HN
t 01382 344765; **f** 01382 348216; **e** g.m.gadd@dundee.ac.uk

Eukaryotic Microbiology – Dr Alastair Goldman
Molecular Biology & Biotechnology, University of Sheffield, Firth Court, Sheffield S10 2TN
t 0114 222 2779; **e** a.goldman@shef.ac.uk

Fermentation & Bioprocessing – Prof. Chris J. Hewitt
Dept of Chemical Engineering, Loughborough University, Loughborough LE11 3TU
t 01509 222503; **e** c.j.hewitt@lboro.ac.uk

Food & Beverages – Dr Cath E. D. Rees
University of Nottingham, School of Biological Sciences, Sutton Bonington Campus, Loughborough LE12 5RD
t 0115 951 6167; **f** 0115 951 6162; **e** cath.rees@nottingham.ac.uk

Irish Branch – Dr Evelyn Doyle
School of Biology and Environmental Science, Ardmore House, University College Dublin, Belfield, Dublin 4, Ireland
t +353 1716 1300; **f** +353 1716 1183; **e** evelyn.doyle@ucd.ie

Microbial Infection – Dr Nick Dorrell
Pathogen Molecular Biology Unit, Dept of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT
t 0207 927 2838; **f** 0207 637 4314; **e** nick.dorrell@lshtm.ac.uk

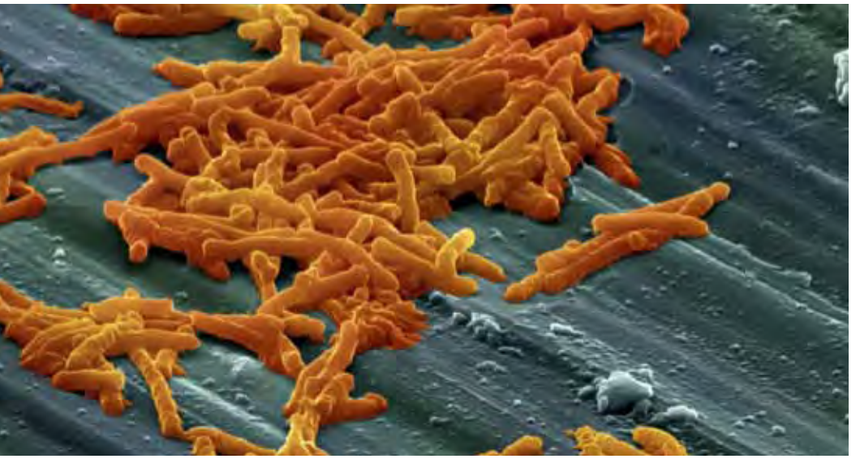
Physiology, Biochemistry & Molecular Genetics – Prof. Maggie C. M. Smith
Molecular & Genetics, University of Aberdeen, Institute of Medical Sciences, Foresterhill, Aberdeen AB25 2ZD
t 01224 555739; **f** 01224 555844; **e** maggie.smith@abdn.ac.uk

Systematics & Evolution – Prof. Niall A. Logan
Dept of Biological and Biomedical Sciences, Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 0BA
t 0141 331 3207/8510 (admin assistant); **f** 0141 331 3208; **e** n.a.logan@gcal.ac.uk

Virus – Prof. Rick E. Randall
School of Biology, Biomolecular Sciences Building, University of St Andrews, North Haugh, St Andrews, Fife KY16 9ST
t 01334 463397; **f** 01334 462595; **e** rer@st-andrews.ac.uk

hotoffthepress

Science writer **Meriel Jones** takes a look at some recent papers in SGM journals which highlight new and exciting developments in microbiological research.



Clostridium difficile –a special issue

Clostridium difficile is a bacterial species that lives in oxygen-free conditions. It is one of the very many types of bacteria in the healthy human gut, and although relatively uncommon in adults, can be detected in at least two out of three infants. However, one side-effect of life-saving antibiotic therapies, first recognized in 1977, can be that *C. difficile* multiplies rapidly and causes diarrhoea, which can be extremely serious and life-threatening.

The biology of the bacterium provides resistance to some antibiotics and also allows it to form structures that are highly resistant to disinfectants and other hygiene measures, making it easily spread in places like hospitals. Indeed, it is now the most frequently identified cause of hospital-acquired diarrhoea.

A system called ribotyping to identify strains of *C. difficile* has been devised at the Cardiff Anaerobe Reference Unit, UK, and is now used worldwide. In the last few years, *C. difficile* has become even more notorious because a new, very virulent epidemic strain (NAP1/027) has emerged in Europe and North America and is responsible for a large increase in both illness and death. At least 27 further very virulent strains have also been identified.

The Second International *C. difficile* Symposium, with delegates from 24 countries in five continents, was held in June 2007 in Maribor in Slovenia. It brought together researchers studying the fundamental biology of this bacterium, clinicians and those focusing on new treatment strategies. The June 2008 issue of *J Med Microbiol* (vol 57, part 6) is devoted to the ideas and information that came from the symposium.

For clinical practice, the way that *C. difficile* is unaffected by the widely used fluoroquinolone antibiotics, used to treat a very wide range of bacterial infections, is very important. The European Study Group on *C. difficile* (ESGCD) reported on the alarming pattern across Europe of increasingly widespread antibiotic resistance. The presence of *C. difficile* disease in farm animals, recounted by Slovenian researchers, suggested a further undesirable possibility of spread through the food chain. In contrast, researchers from the Alimentary Pharmabiotic Centre in Ireland supplied the novel idea for a therapy using designer probiotics to neutralize both *C. difficile* cells and toxins in the gut.

There is an essential link between the amount of toxins (toxin A and toxin B) produced by *C. difficile* and the severity of the illness. The biosynthesis of the toxins is controlled by a series of positive and negative controls within the cell, in response to the cell's environment. The human gut is stressful for bacteria, and researchers from the UK presented their initial analysis of how all the genes within *C. difficile* react to this situation. Partial loss of control over toxin biosynthesis, as well as resistance to antibiotics, is characteristic of the epidemic strains. French and German researchers told the symposium about studies hinting that antibiotics may actually influence the ability of *C. difficile* to colonize the gut as well as affecting toxin production. In addition *C. difficile* can synthesize, and tolerate, the toxic disinfectant *p*-cresol and researchers from the London School of Hygiene and Tropical Medicine, UK, presented their work looking at whether this provided any competitive advantage. Their study showed that two of the virulent strains tolerated significantly higher levels of *p*-cresol than some others. In addition, researchers in Scotland described their experiments indicating that toxin potency might be affected by additional proteins on the *C. difficile* surface.

The toxins are large, complex, sugar-coated proteins that recognize the surface of human cells, get inside and then wreak havoc in the gut. Researchers at both the Institut Pasteur in Paris, France, and the University of Freiburg, Germany, provided overviews of the current ideas on exactly how these processes happen. The damage is caused because the toxins attach a glucose molecule to a specific point in human proteins that are essential for transmitting signals within cells. This can kill the cells and researchers from Hannover Medical School in Germany talked about their detailed study of these events. Despite several gaps in our knowledge, the importance of the toxins to illness is very clear and has led to suggestions that a new therapeutic approach would be to develop compounds that block recognition between the toxins and human cells.

The immune system is essential in resistance to bacterial infections and researchers from the University of Edinburgh, UK, showed very clearly that patients with illness caused by *C. difficile* did not differ from apparently healthy people harbouring the bacterium in terms of their immune response. This is good news for proposals to develop treatments, including vaccines, that rely on the immune system, recounted by scientists from Italy, Ireland and the UK.

◀ Coloured SEM of *C. difficile* on a surface. *Annie Cavanagh and Dave McCarthy/ Wellcome Images*

Researchers from around the world shared information about the prevalence of *C. difficile* in hospitals within their own countries. For example, scientists from the Netherlands explained how the realization that NAP1/027 strains had caused epidemics in eight Dutch hospitals in 2005 led rapidly to new hygiene guidelines and a review of the use of antibiotics prior to each outbreak. Staff from the Austrian Agency for Health and Food Safety had checked 149 samples from Austrian hospital laboratories in 2006 to discover what ribotypes were present and whether they differed in lethality. They identified 41 different ribotypes and pointed out that finding several infections with the same ribotype in a hospital should prompt an in-depth investigation in case the source was in the hospital itself. Twelve of the patients had died, infected with six different ribotypes, illustrating that there is serious danger from more than the NAP1/027 strain.

The experience of Korean researchers between 2000 and 2005 made the point that some epidemic strains lack toxin A. The prevalence of these strains has been between 0.2 and 56 % in reports from around the world. Unfortunately, some tests rely on detecting this toxin so that the infection is mis-diagnosed, emphasizing the importance of developing appropriate routine identification methods. In addition, work from the research group at the London School of Hygiene and Tropical Medicine, UK, indicated that the toxin situation was becoming even more complex since some virulent strains have novel versions of toxin B.

At the end of the symposium, the delegates agreed what the future research priorities should be. Advances have be made on several since June 2007, and they include the areas of epidemiology, establishment of better nomenclature and typing systems for isolates, and research to gain greater understanding of both pathogenesis of the bacterium and the reasons for susceptibility of its unwilling human hosts.

Pig gut bug

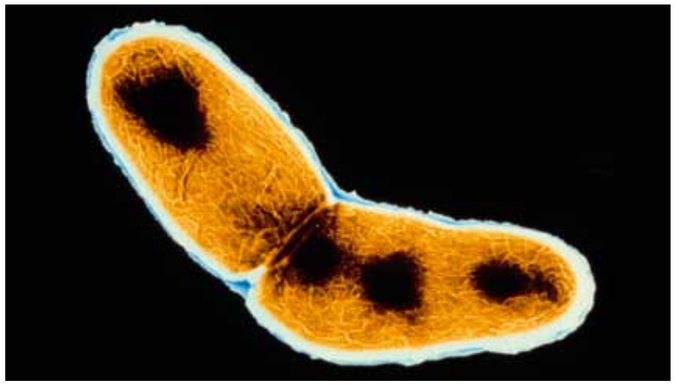
Baele, M., Decostere, A., Vandamme, P., Ceelen, L., Hellemans, A., Mast, J., Chiers, K., Ducatelle, R. & Haesebrouck, F. (2008). Isolation and characterization of *Helicobacter suis* sp. nov. from pig stomachs. *Int J Syst Evol Microbiol* **58**, 1350–1358.

The bacterial species *Helicobacter pylori* lives in the stomachs of about half the human population and is involved in causing stomach ulcers. Its spiral-shaped cells inhabit the mucus lining of the highly acidic stomach. Researchers have also detected other helicobacters in some people, distinguished by their more tightly coiled spiral-shaped cells and differences in gene sequences. These bacteria also have an association with stomach ulcers and lymphoma. They have been provisionally named *Helicobacter heilmannii*, although there seems to be more than one type. Unfortunately, it has proved impossible to grow *H. heilmannii* type 1 as a pure culture in the laboratory, hindering further investigation.

Helicobacter species also live in animal stomachs. For example, DNA from '*Candidatus* Helicobacter suis' can be detected in at least 60 % of all pigs. Although these bacteria were first observed around 1990, they also have never been isolated or studied in detail. Researchers at Ghent University in Belgium became interested because, in addition to a potential role in animal welfare as the cause of ulcers and gastritis in pigs, the only piece of molecular genetic information matched some helicobacters from people suspiciously well. There was also epidemiological evidence that people who had contact with pigs had a higher risk of *H. heilmannii* infection, suggesting that the bacteria might transfer from pigs to humans.

To resolve the identity of these pig bacteria, the Belgian researchers went to great lengths to devise a way to grow them in the laboratory. Finally, starting from the mucus scraped from pig's stomachs that had been soaked in dilute acid, they were able to obtain cultures. The special growth medium they devised contained a complex mixture of components, including activated charcoal, vitamins and several antibiotics maintained in an atmosphere that was very low in oxygen and high in carbon dioxide. Obtaining a quantity of pure '*Candidatus* Helicobacter suis' allowed them, for the first time, to perform a battery of cultural and molecular tests on the bacteria.

The results made it very clear that the bacteria from pigs belong to the same species as type 1 strains of *H. heilmannii* from people, and are different from any other well-characterized species of *Helicobacter*. To resolve the question of what to call it, the researchers have proposed that *Helicobacter suis* is used from now on.



▲ Coloured TEM of *M. tuberculosis*. *Kwangshin Kim / Science Photo Library*

Fat target for TB treatment

Bhowruth, V., Brown, A.K. & Besra, G.S. (2008). Synthesis and biological evaluation of NAS-21 and NAS-91 analogues as potential inhibitors of the mycobacterial FAS-II dehydratase enzyme Rv0636. *Microbiology* **154**, 1866–1875.

Tuberculosis is making an unwanted return around the world. Worryingly, some new strains are resistant to most or even all of the therapeutic drugs. Isoniazid is the current mainstay in treatments. It interferes with the synthesis of mycolic acids that form an essential, fat-rich permeability barrier around the *Mycobacterium tuberculosis* cell. Researchers would like to find more drugs that affect this process to provide treatments for the new drug-resistant cases of TB.

Mycolic acid biosynthesis involves two enzyme complexes and the second one, FAS-II, only occurs in bacteria, plants and some parasites. The enzymes take long-chain fatty acids and make them even longer, adding some chemical modifications along the way. Some of the steps are unique to *Mycobacterium* species. Although the genome of *M. tuberculosis* has been sequenced, researchers are still not quite sure what some of the genes do. In addition, although they understand the process that makes mycolic acids, there is still a debate about exactly which genes in *M. tuberculosis* provide the instructions for each step. A key step is dehydration and the gene *Rv0636* is a strong candidate for control of the process. Finding chemical compounds that inhibit this step could solve the identity of the gene and suggest new therapies.

Researchers at the University of Birmingham, UK, are looking for new anti-TB drugs. They have tested the effects of two series of chemicals that should inhibit the dehydration enzyme activity. In each case, they started with a chemical that was already known to inhibit the enzyme, made a small modification to this chemical and then tested the new, pure chemical for its effect on both the growth of *Mycobacterium* cells and FAS-II enzyme activity. In addition to normal *Mycobacterium* cells, they also tested cells that produced high levels of the *Rv0636* gene product.

Some of their modifications to a chemical called NAS-21 were very effective against the *Mycobacterium* cells, and cells with lots of the *Rv0636* gene product were particularly resistant. Some changes to a second chemical, NAS-91, also made it more toxic to the cells. When the researchers tested the effect of the chemicals on an authentic FAS-II enzyme, the chemicals that had most effect on the bacterial cells also caused most inhibition of the enzyme. The coincidence of these results is a strong indication that *Rv0636* is the gene for the essential dehydratase. The chemicals themselves may be candidates for further development towards new drugs that may eventually be useful for treating TB.

Maddeningly elusive

Julius, C., Heikenwalder, M., Schwarz, P., Marcel, A., Karin, M., Prinz, M., Pasparakis, M. & Aguzzi, A. (2008). Prion propagation in mice lacking central nervous system NF-κB signalling. *J Gen Virol* **89**, 1545–1550.

The defining feature of transmissible spongiform encephalopathies like BSE and scrapie is that a mis-folded prion protein accumulates in the brain and the appearance of the brain tissue changes as cells die and gaps form. The result is distressing changes in behaviour and invariably death. Scientists have no idea how the abnormal protein causes these dramatic effects. However, there are well-known physiological systems, including the NF-κB signalling pathways, that carry signals for inflammation and regulate cell death which are activated in other neurodegenerative diseases like Alzheimer's and Parkinson's diseases. Researchers have conflicting evidence for the role of this pathway in BSE. In principle, NF-κB signalling could be beneficial or deleterious, depending on the consequences of the signals. These could enhance the survival of neurons by inducing processes that counter cell death, or promote their death through the release of toxic molecules.

An international research effort, led by Adriano Aguzzi in Switzerland, has now taken the approach of recording the progress of prion disease in mice that lack components of the NF-κB pathway. One set of mice lacked a component for pro-inflammatory signalling in most brain cells while others lacked part of an alternative NF-κB signalling pathway throughout their bodies. Surprisingly, the researchers could not detect any difference between the symptoms and progress of the disease in these and normal mice.

The implication is that the NF-κB pathways are not important in prion disease, despite their importance in regulating the immune response and thus in processes such as cancer and autoimmune diseases. The mechanisms for loss of brain cells during BSE continue to be elusive.

Science communication takes many forms. In this issue we cover some of the latest ways by which microbiologists can keep in touch with each other and their subject. We also pay a visit to the Welsh Assembly to promote microbiology.

Microbiology and new media

If I wanted to, in the next 5 minutes I could download a podcast about astrobiology, comment on a blog discussing the pros and cons of mandatory vaccination, watch an instructional video teaching me how to streak an agar plate and join a group of sexy microbiologists just by clicking my computer mouse a few times. Such are the benefits of new media and web 2.0 technology. The advantages to me as a consumer are clear: I have a wealth of information, in a variety of formats, at my fingertips. I can even interact with the information, offering feedback and opinions. But what's in it for microbiology?

▲ *Photos.com / Jupiter Images*

Podcasts

The term 'new media' can be rather vague. It is often applied to anything internet-based that isn't a static web page. One such application is a podcast: an audio file that is connected to an RSS feed, which enables subscribers to be alerted when a new (usually regular and frequent) episode is available. Perhaps unsurprisingly, the majority of the most popular podcasts are based on music and comedy (15 of today's top 25 podcasts on *iTunes* have comedy content; 2 are factual) but there is certainly a place for science. *The Naked Scientists*' podcast and *The Guardian*'s *Science Weekly* are both popular in the 'Science and Medicine' category, and microbiology is not neglected. A handful of podcasts is available by (free) subscription, including the ASM's *Microbeworld*, University of Leicester's (Dr Alan Cann) *MicrobiologyBytes*, and *Micropod online*, the product of a recent collaboration between SGM and the Society for Applied Microbiology (SfAM) (www.micropod online.com/podcast.html).

For the ASM, University of Leicester, SGM and SfAM, podcasts are a new way to make information available to the public. (*MicrobiologyBytes* has attracted 100,000 downloads in the last year and there are approximately 1,500 regular weekly subscribers.)

These three podcasts cover a spectrum of understanding, aimed at everyone from the interested school student and the concerned parent to the postdoc researcher and the seasoned scientist. Just like a magazine, information can be presented in different ways, including news items, discussions and interviews. The content is convenient to the user who, perhaps, does not have time to sit and read a monthly magazine, but can easily listen to a 10-minute podcast while walking to work, driving, etc. But perhaps most importantly, by making audio available, the producers are better connected to the users, making them feel more involved with the subject matter and therefore likely to return for more. And hearing a scientist speak about their research makes it real, accessible, understandable and relevant.

Video

Around 9% of *BBC Online* content is video. People are watching less television, preferring to find relevant video content to view online. Videos access yet another audience, which may otherwise remain out of reach. For example, *YouTube* attracts around 20 million views each month and is popular with a younger audience. The number one viewed microbiology video on *YouTube* is called *We are not alone* (http://tinyurl.com/5xyqu6). It has had 257,451 views and been awarded a 5-star rating by the viewers. It is a short video with some basic information about creepy crawlies that live on us humans, including microbes. Other popular videos include *Bacterial conjugation* (http://tinyurl.com/yvehqs) with 28,296 views and *Great microbiologists*, as told by Lego men (http://tinyurl.com/6akanj).

Many of the microbiology videos on *YouTube* are aimed at students. It is possible to learn all sorts of things, from the history of microbiology to plate-streaking methods. Videos come from a multitude of different sources, including universities, labs and people's living rooms. The benefit? According to YouTube.com: '*Everyone can watch videos on* YouTube. *People can see first-hand accounts of current events, find videos about their hobbies and interests, and discover the quirky and unusual. As more people capture special moments on video,* YouTube *is empowering them to become the broadcasters of tomorrow* (YouTube.com, May 2008).

Blogs

New media has brought along with it a cascade of new words, which can make it seem even more difficult to decode. One of these is blog. Blog comes from the term web log, which refers to a web page or website content that is written and maintained regularly, often consisting of opinions and descriptions of events – a sort of online diary. The word can also be used as a verb, meaning to write or maintain a blog. Blogs can be (and are) written on just about everything imaginable, including microbiology. According to Google, *MicrobiologyBytes* is the most popular microbiology blog: with over 250,000 page views in the last year. ASM also has a blog, *Small Things Considered*.

Our own blog (www.micropodonline.com/blog) covers diverse topics, including the effect of TV adverts on the public opinion of microbes and the increase in STIs at Christmas. For blog authors, a major advantage is the facility that enables readers to comment and provide feedback.

Social networks

Social networks are beginning to grow out of the blogging world. *Twitter.com* is a fledgling network that is based on 'real-time micro-blogging': people interact via short (140 character) blogs. Twitterers can reply to each other's 'tweets', creating a dialogue in a network. Yesterday, I asked for opinions. Googler martynj said '*I think Twitter's great for serendipitous discovery of complimentary ideas/techs.*' AJcann said '*Benefits to microbiology = community of practice, especially for professionally isolated folks.*'

Social networks are often in the spotlight. An estimated 200 million people are registered on *MySpace* and at least 170 million people are on *Facebook*. In the UK, *Bebo* ranks second in the social network ranks and was purchased in March 2008 by AOL for $850 million (http://tinyurl.com/3ac2c8). *Bebo*, *YouTube*, *Facebook* and *MySpace* are in the top 10 most searched for items in 2007 (http://tinyurl.com/5vf6vc) and 1 in 50 UK network visits are to Facebook (http://tinyurl.com/yt6ax5).

Social networks provide facilities for like-minded people to gather virtually and share links, videos, podcasts, pictures and ideas. People group themselves in all sorts of ways, by profession (e.g. microbiologists), by hobby (e.g. brewing), by interest (e.g. microbiology) and even by campaign (e.g. '*I support the HPV vaccine!*'). The group *Micropodonline* is made up of all sorts of people, each with an interest in topical microbiology. Some social networks are tailored to science and scientists. *Nature Network* enables

A few useful URLs

What?	Who for?	Where?
Nature Network	Professional scientists	http://network.nature.com/
Biomed Experts	Professional scientists	www.biomedexperts.com
Facebook	Everyone	www.facebook.com
MySpace	Everyone	www.myspace.com
	(micropod online group	http://tinyurl.com/5lqhgf)
Twitter	Bloggers	www.twitter.com
Plurk	Bloggers	www.plurk.com
Second Life	People with some spare time	www.secondlife.com
YouTube	Video lovers	www.youtube.com
UStream	Video lovers	www.ustream.tv

scientists to create a professional profile, including their areas of expertise, interests and publications. Members can discuss scientific issues and methodology, or just discuss last night's episode of a TV soap. *BiomedExperts*, 'your scientific match point' is similar to *Nature Network*; and is created around professional collaborations; members are connected by publication, becoming part of a huge group of associated researchers.

Virtual worlds

Taking this one step further, you reach virtual worlds, where your online profile is given a 3-dimensional presence, or avatar. As Mellifera Slade in *Second Life*, I can talk to my virtual friends using my real voice. I can attend lectures (a recent event on the *Nature Island* was a talk on bluetongue virus), peruse the literature at the *Second Life* Centers for Disease Control and Prevention building or sit under a parasol and listen to the latest episode of the *Nature* podcast. Virtual worlds give institutions the opportunity to create virtual areas that are accessible to anybody with a computer. More than 100 universities have campuses in *Second Life*, on which courses are run and lectures given. According to Peter Armstrong, founder of OneWorld.net, it won't be possible for people to fly to conferences in the future, due to the pressures of climate change. *Second Life* is an opportunity for people to meet without having to travel. '*We tested it last December against the UN CCC meeting in Indonesia, to see whether we could add value to that event, open a window for extra participation for people over that fortnight.*' The virtual event was a huge success, becoming a model for similar events in the future.

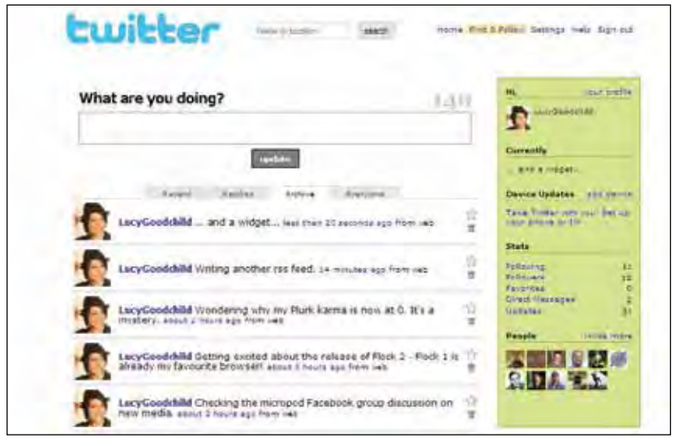
What next?

So what does the future hold? Gone are the days when it was sufficient to put something interesting on a website and let people find it. Alan Cann thinks there will be a '*growth in participatory media and user-generated content. Much of this will be driven by social networks such as* Facebook *and* Twitter. *There will also be a lot more user-generated video chat through sites such as* Ustream.tv *and* Seesmic.' To hear Alan's response in true web 2.0 style, see http://seesmic.com/v/x12PBvDIco

It is projected that by 2012, 80% of online interaction will be via virtual worlds. Does this mean we should throw away our pens and paper? I don't think so. Whatever happens, there will still be a place for traditional media. People enjoy flicking through a magazine, reading a newspaper, watching TV and listening to the radio. As the horizon changes, plain information will still be needed to form the basis of new content, be it a podcast, blog or discussion forum. Microbiology can certainly benefit from new media by making itself accessible to users, therefore more readily consumed. Microbiologists themselves will benefit from being part of online networks, but this does not spell the end for traditional conferences. To make the most of new media, we first have to be willing to dip our toes into web 2.0.

SGM has done just this. www.micropodonline.com is proving to be a success, followed by the recent launch of the SGM journals podcast (see p. 113). We have a *Facebook* group, a *MySpace* page, *Wikipedia* entries and RSS feeds in development – watch this (virtual) space! To find out more or how to contact me via web 2.0, email l.goodchild@sgm.ac.uk

***Lucy Goodchild**, SGM External Relations Administrator*



MicrobiologyBytes videos

The widespread availability of broadband internet makes it highly feasible to distribute short video clips online. As Lucy Goodchild describes on p. 150, the most obvious manifestation of this potential is the rapid growth in popularity of *YouTube* and similar video-sharing services. A recent report indicates that *YouTube* looks set to overtake BBC.co.uk in its share of UK website visits (http://tinyurl.com/34gndf). Although the penetration of this technology into the student population is very high, teachers and academic staff are lagging seriously behind in the take-up of this new form of communication. Online video has a high acceptability to young learners. In addition to ongoing investment by educational institutions, online video provides enormous flexibility to learners via computers, game consoles and mobile devices such as phones and video players.

In a past issue of *Microbiology Today*, I have described the great and still increasing success of my blog and podcasts on microbiologybytes.wordpress.com This site has achieved its aim of engaging with the public about topical aspects of microbiology. I have also conducted pilot experiments with video formats in the podcast and blog, and these have been very popular. With the support of an award from the Society, I am currently producing at least one video podcast per month (http://tinyurl.com/5zbmgw). The production of video is more time-demanding than the production of an audio podcast, but the new audience and publication channels the video format makes possible means that this is worthwhile. The videos are 'branded' with the SGM identity and a link to the Society website.

The aims of *MicrobiologyBytes* are to:

- Promote understanding and awareness of current issues in microbiology in the general public, potential students of microbiology and the media
- Promote awareness of SGM, benefits of membership, and resources available on the Society's website
- Promote awareness of career possibilities in microbiology and microbiology-related fields.

Based on the success of the last year, I believe these aims have been realized, but extension of the project into the highly attractive online video field will further increase the audience.

Alan Cann
University of Leicester (e alan.cann@leicester.ac.uk)

Science and the Welsh Assembly

On Tuesday 20th May, the Royal Society of Chemistry held its annual *Science and the Assembly* event in Cardiff, split between the fabulous Wales Millennium Centre and the stylish Senedd.

This event aims to bring together scientists and the Welsh Assembly to discuss topical science issues, and began with a keynote speech from Jane Davidson AM, Minister for Environment, Sustainability and Housing. High profile researchers from around Wales then delivered scientific presentations. Afterwards, a buffet and exhibition in the Senedd, specifically timed to follow the Assembly's plenary session that afternoon, allowed the delegates to mingle and chat, as well as explore the displays.

The SGM participated in the exhibition. With the ongoing public inquiry into the 2005 outbreak of *Escherichia coli* O157, the largest ever outbreak in Wales, it seemed appropriate to present information on the food-poisoning agent verocytotoxin-producing *E. coli* (VTEC). This included a short movie showing the interaction of *E. coli* O157 with the epithelia of the gastrointestinal tract.

The Senedd is a space open to the public and throughout the day there was significant interest in the SGM display. The hand soaps (there to promote good hand hygiene, which is key in helping to prevent food poisoning) were especially popular with visiting school children.

However, the undisputed talking point of the day at the Senedd, which divided opinions of visitors and politicians alike, was the huge tinplate portrait of Baroness Margaret Thatcher that had been hung against the glass windows at the front of the building. Visible from both inside and out, this temporary artwork, which was due to be unveiled the next day, was one of a pair. The other portrait was of NHS founder and Welsh hero, Aneurin Bevan.

Faye Stokes
Public Affairs Administrator

Further reading

www.rsc.org/ScienceAndTechnology/Parliament/Events/ScienceandtheAssembly2008.asp

http://new.wales.gov.uk/ecoliinquiry/?lang=en

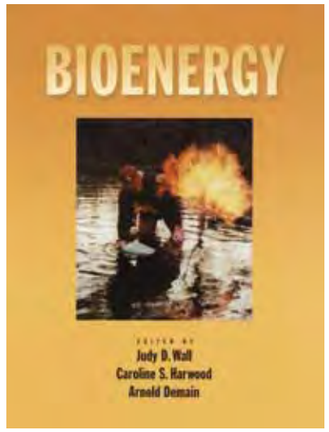
www.sgm.ac.uk/news/hot_topics.cfm

www.vet.ed.ac.uk/zap/research/highlights_movie.htm

http://news.bbc.co.uk/1/hi/wales/7411199.stm

reviews

If you would like your name to be added to our database of book reviewers, please complete the book reviewer interests form at **www.sgm.ac.uk**. A classified compendium of reviews from 1996 to the present is also available on the website.



Bioenergy

Edited by J.D. Wall, C.S. Harwood & A. Demain
Published by American Society for Microbiology (2008)
US$139.95 pp. 454
ISBN 9-78155-581-4

Surely any book with a picture of an explosion on the cover has to be worth browsing? In this respect *Bioenergy* does not disappoint. The editors have sought to identify and summarize the areas in which microbiology could play a part in producing renewable energy. The text is made up of 31 reviews written by researchers active in these areas and provides an excellent condensed summary of each area and the current state-of-the-art for each subject. Due to the style of presentation, there is inevitably some overlap in the content of different chapters, and some conflicting opinions or interpretations of recent results. *Bioenergy* provides an excellent primer for students or researchers new to this exciting area. The picture of the recreation of the Volta experiment on the front of the book means that anyone with an interest in microbial alternative energy production should consider obtaining a copy.

***James Chong**, University of York*

Archaea – New Models for Prokaryotic Biology

Edited by P. Blum
Published by Caister Academic Press (2008)
£150.00 / US$300.00 pp. 247
ISBN 1-90445-527-1

After avoiding the limelight for about three billion years, *Archaea* were outed in the 1970s and 80s by molecular phylogenetics (Carl Woese) and biochemical studies on RNA polymerase (Wolfram Zillig & others). This led to the new prokaryotic domain *Archaea* arising from '*Archaeabacteria*', the label previously held by these organisms within domain *Bacteria*. This new book on *Archaea* settles on two main themes: nucleic acid processing and bioenergetics/metabolism, with additional chapters that could be bundled loosely as systems biology. In the latter I particularly enjoyed a review on signal transduction in archaea, which captures the frontiersman spirit of some research into *Archaea*.

The book begins with some hardcore biochemistry, which is mercifully well organized and interesting, reviewing the metabolic diversity that allows *Archaea* to occupy bizarre habitats. The front cover of the book also expresses this well, showing a relaxed bison affront steaming solfataras. I was drawn to the chapter reviewing *Archaea*–metal interactions; an unusual topic that was easy to read. Chapters on DNA and RNA processing are covered with varying degrees of thoroughness and there is some overlap. In chapter 7, on DNA repair, the subsection covering recombination is sketchy and badly referenced, but chapter 6, on recombination, is excellent in covering this in detail. The chapter on DNA replication holds it own against several recent review articles in journals.

The book is timely and the publishers promise a 'state-of-the-art overview of *Archaea*'. In this it mostly works, and its slimness (246 pages) reflects a concise and mostly well-referenced style. It would be a pity if the hefty price (£150) discourages buying it outright, because it conveys plenty of the novelty and oddity in *Archaea* that captures the imagination of students, researchers and PIs. I hope it does not become a reference work that struggles to make it beyond the doors of the university library.

***Edward Bolt**, University of Nottingham*

Leishmania After the Genome

Edited by P.J. Myler & N. Fasel
Published by Caister Academic Press (2008)
£150.00 / US$300.00 pp. 308
ISBN 1-90445-528-8

With the laudable aim of showing 'how the genome has informed and changed our understanding of the biology of *Leishmania*' and 'the implications in terms of discovering novel diagnostics, chemotherapeutic agents and vaccines', 48 authors in 13 chapters unzip the molecular biology of the pathogen that causes the complex parasitic disease leishmaniasis. The *Leishmania* parasite is a flagellated protozoan, existing as an extracellular promastigote in the female sandfly vector and as an intracellular amastigote in the mammalian host, where it survives and multiplies in the inhospitable location of the phagolysomal compartment of the macrophage, and subsequently subverts the host immune response to cause leishmaniasis. The understanding of the mechanisms that enable this process, the variation between the 17 different species of *Leishmania* that infect humans, and their different tissue tropisms and virulence patterns pose a major challenge. The genome (and ancillary '-omes') are helping us to resolve some of these questions. The recent publication by Peacock *et al.* (2007) has demonstrated how some of the challenges around species differences can be unravelled. More will come when studies are more focused on the disease relevant amastigote and we are clearer about the predictive value of mouse models for human disease.

The volume is up-to-date; the genome was published in 2005 and the most recent references in the book were published in 2007. There is a richness of information – chapters on gene regulation and the metabolome are particularly engaging. It is therefore a shame that some errors, for example over chemotherapy (details and facts), in other chapters create concern. A further problem lies in the aims of the volume itself and the concept of 'implications'. The premature expectation of great revelations from the genome is a minor concern compared with the expectation that the genome is the basis of discovery of new tools for disease control – it is only a small (and early part) of the process. As pointed out in the vaccine chapter, the 'roadblock is to identify a mode of delivery'. With a disease where the real burden of infection in humans in unknown, where the introduction of new drugs is threatened by misuse, where the differing sensitivities of diagnostics between countries cannot be explained, complex problems must be considered at all levels from the genome to access. Let us enjoy a volume that provides a valuable overview of the molecular biology and biochemistry of these fascinating parasites, their metabolic pathways, differentiation process, and their surface molecules without burdening important scientific advances with unreal expectations.

***Simon L. Croft**, London School of Hygiene and Tropical Medicine*

Staphylococcus Molecular Genetics

Edited by J.A. Lindsay
Published by Caister Academic Press (2008)
£150.00 / US$300.00 pp. 278
ISBN 1-90445-529-5

This is an incredibly useful book for anyone with in interest in staphylococci. It provides a broad and in-depth synopsis of up-to-date staphylococcal research. This book is very well suited to its target audiences, researchers who are relatively new to the field and also as a suitable reference for those with greater experience.

The first five chapters are particularly informative, providing an excellent overview of the staphylococcal sequencing projects, population structure and evolution of *S. aureus*, as well as analysis of the methods used. A lot of focus is placed on published data from the UK, perhaps not fully recognizing the interesting and often challenging problems of day-to-day hospital- and community-acquired infections of *S. aureus* on a more international level.

The chapter on 'Global regulators of *Staphylococcus aureus* virulence genes' is excellent. There is a multitude of publications concerning the regulation of virulence and this chapter provides a thorough review of the literature. Our main criticism is that although the book is entitled *Staphylococcus Molecular Genetics*, seven chapters are devoted entirely to *S. aureus* with only one chapter describing *S. epidermidis* and other coagulase-negative staphylococci. This undoubtedly reflects the current staphylococcal research situation where the focus is placed the clinical importance of *S. aureus*.

We hope that this book will be regularly reviewed and updated in line with this rapidly expanding field.

***Madeline Stone** & **Kathy Bamford**, Imperial College London*

Reviews on the web

Reviews of the following books are available on the website at www.sgm.ac.uk/pubs/micro_today/reviews.cfm

Sulphate-reducing Bacteria – Environmental and Engineered Systems

Microbes for Human Life

Sampling for Biological Agents in the Environment

Pneumococcal Vaccines

Emerging Protozoan Pathogens

New Antibiotic Targets

The Study of Plant Disease Epidemics

Antimicrobial Drugs – Chronicle of a Twentieth Century Medical Triumph

Vaccination: A Tool for the Control of Avian Influenza

Bacterial Pathogenesis: Methods and Protocols

RNA and the Regulation of Gene Expression: A Hidden Layer of Complexity

Bacterial Physiology and Metabolism

How to Write and Illustrate a Scientific Paper, 2nd edn

Corynebacteria*: Genomics and Molecular Biology*

Plasmids: Current Research and Future Trends

comment

Bad reporting in the media is hard to swallow

Microbiology is almost always in the news. But how reliable is its reporting? While a high profile for our discipline is welcome, **John Heritage** wonders if this comes at the expense of misrepresentation and public misunderstanding of the issues?

A popular television news programme recently ran a campaign based around matters microbiological. My heart sank as I watched the daily reports, based in a kitchen in 'Middle England', showed how easily 'bacteria' can be spread by cleaning materials: assuming all bacteria to be bad. I am not for one moment suggesting that we should ignore the dangers posed by pathogenic bacteria that use food as a vector for infection or intoxication; nor do I believe that unhygienic practices are to be encouraged. What concerns me is the demonization and trivialization of microbes to grab viewers.

Further disappointment ensued on visiting the programme's website, where I found that 'The number of cases [of *E. coli* O157] in the UK has tripled in the last decade, jumping from 361 in 1991 to over 1,000 in 1997.' Those figures are over 11 years old! In 1997 human cases of *E. coli* O157 peaked, with over 1,087 isolates referred to the Health Protection Agency. There followed a sharp decline in referrals until 2002 when there were 595 human isolates, with a steep rise to 1,003 cases in 2003. It seems lazy to report old data, particularly when the new data are even more interesting. What is more, within two sentences the programme's subsequent website refers both to 'O157' and '0157'. I am sure a significant proportion of microbiology undergraduates, at least at Level 1, may struggle to identify which is correct, let alone tell you what the 'O' in 'O157' means, but it is simply sloppy reporting to use both without questioning which is correct, and why.

Later in the week, viewers were treated to a demonstration, again from a kitchen, of the difference between 'best before', 'sell by' and 'use by' dates. To illustrate the point, among other items, the reporter pulled a yoghurt carton from the fridge that was beyond its 'sell by' date and questioned the family about whether they would eat it. Part of the question contained the, to my ears somewhat sneering, suggestion that 'experts say that eating this is probably safe'. The irony here is that yoghurt evolved as a method of safe food preservation; a means of prolonging the shelf life of an otherwise highly perishable foodstuff.

Perhaps I am sensitive to the reporting of science by the media. After all, I was the 'scientist(s) [who] warn of GM crops link to meningitis', according to one national newspaper – I believe this to be a gross misrepresentation of my views. This caused me significant problems for a few hours. I was, however, greatly comforted by a piece of advice from a senior civil servant with whom I spoke as the storm raged: '… today's newspapers are tomorrow's fish and chip wrappings'.

What is the answer? I believe we need better education and better communication. At Leeds, we have a synoptic module in which students develop their critical analysis. The most popular examination question this year, and the one that attracted the highest mean score, was a critical analysis of a microbiology-themed newspaper article. We must also learn to communicate better with journalists. Theirs is not an easy life; they need to become instant experts on topics dictated by their editors. When journalists seek our advice, we should not try to dodge our responsibilities to explain as clearly as possible the science behind the story. Given the deadlines to which they work, we should not be surprised that offers to check articles for veracity are often not taken up. By improving communication we will have a better-educated media, which, in turn, will inform the public more accurately.

▲ *'Today's newspapers are tomorrow's fish and chip wrappings.' GustoImages / Science Photo Library*

John Heritage
Senior Lecturer, Faculty of Biological Sciences, University of Leeds, Leeds LS2 9JT (t 0113 343 5592; e j.heritage@leeds.ac.uk)

Further reading

Verocytotoxin-producing E. coli *O157 strains examined by LEP reported to the Health Protection Agency Centre for Infections. Isolations from Humans England & Wales, 1982–2006*. HPA [www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1195733780833?p=1204031521097 (accessed 16.06.08)].

Please note that views expressed in Comment do not necessarily reflect official policy of the SGM Council.