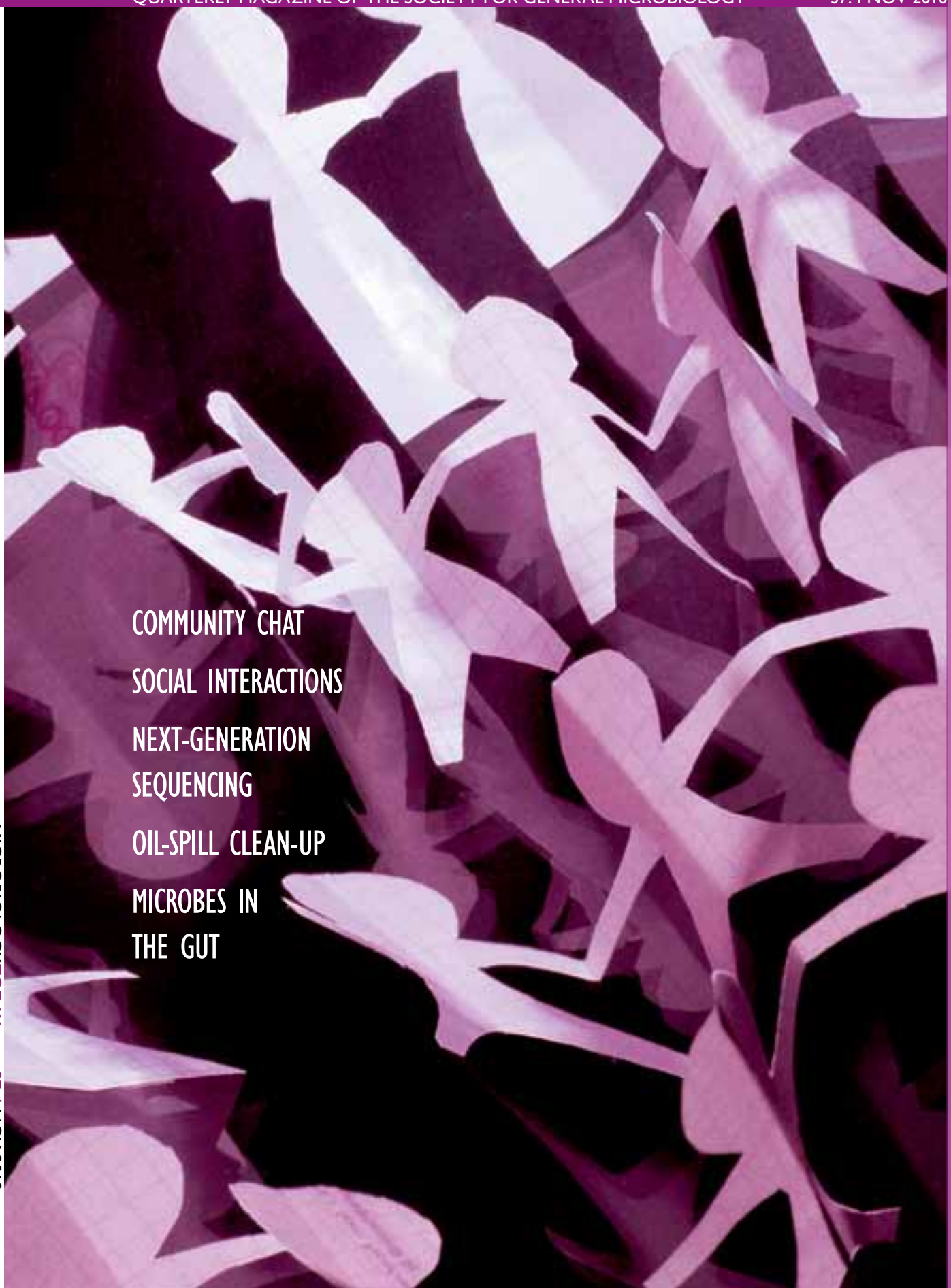
MICRO BIOLOGY TODAY

QUARTERLY MAGAZINE OF THE SOCIETY FOR GENERAL MICROBIOLOGY 37:4 NOV 2010



COMMUNITY CHAT

SOCIAL INTERACTIONS

NEXT-GENERATION SEQUENCING

OIL-SPILL CLEAN-UP

MICROBES IN THE GUT

MICROBIAL COMMUNITIES: BIG SOCIETY ON A SMALL SCALE

MICROBIOLOGY TODAY 37:4 NOV 2010

COVER IMAGE
Interaction in a community. *Hemera / Thinkstock*

ADDRESS
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
James Priest, Group Sales Manager, Ten Alps Media, ONE New Oxford Street, London WC1A 1NU
TEL 0207 657 1804
FAX 0207 379 7115
EMAIL james.priest@tenalps.com

ISSN 1464-0570

PRINTED BY
Latimer Trend & Co. Ltd, Plymouth, UK

FEATURES

REGULARS

PLUS…

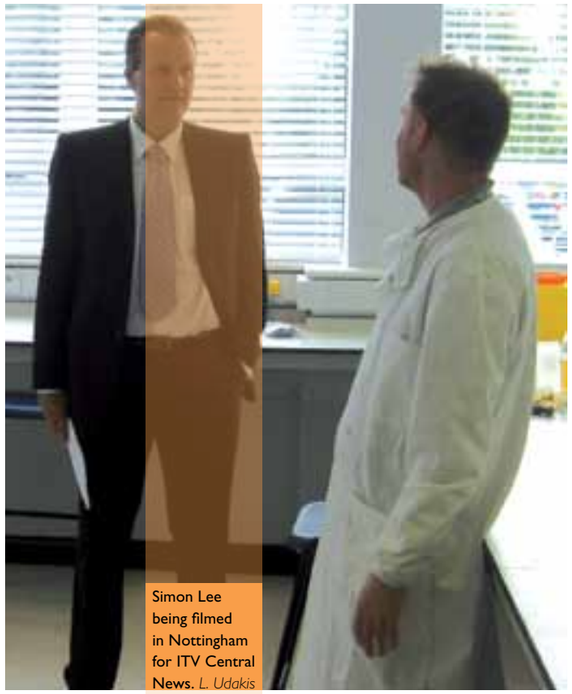
37:4 NOV 2010

CONTENTS

MEDIA FRENZY IN NOTTINGHAM

We had fantastic media coverage for presentations at the SGM Autumn Conference back in September. Nine press releases were sent out to the media, highlighting some very newsworthy microbiology. Widespread interest in several of these left the phone ringing off the hook for the duration of the conference! This resulted in some great print articles in the national, local and specialist press, as well as numerous radio and TV clips.

Undoubtedly the biggest story from the conference was Simon Lee's work on the antimicrobial properties of the brains of cockroaches and locusts. Massive coverage in the nationals and the tabloids followed the press release and led to interviews with Radio 5, BBC Radio Nottingham, RTE Irish News and BBC World View. The Press Association and ITV Central News also came to do some filming which led to a certain buzz about the Nottingham campus.



Simon Lee being filmed in Nottingham for ITV Central News. *L. Udakis*

Sunday Telegraph

How bugs can cure superbugs

MICHAEL HOWIE

THEY ARE among the world's most reviled creatures, but cockroaches and locusts could hold the secret to new ways of combating deadly bacterial infections.

Scientists discovered that the insects have powerful antibiotic molecules in their brains that could be used to develop new treatments for MRSA and *E-coli*.

The researchers, at Nottingham University, found tissues of the insects' brains and nervous systems were able to kill more than 90 per cent of MRSA and *E-coli* bacteria, without harming human cells.

Simon Lee, who led the study, said: "We hope these molecules could eventually be developed into treatments for *E-coli* and MRSA infections that are increasingly resistant to current drugs."

Nottingham Post

Yeast study may lead to disease cure

YEAST could hold the key to treating Parkinson's disease, a conference in Nottingham will hear today.

Portugal-based scientist Dr Tiago Fleming Outeiro will present his work into finding a cure for the disease at the Society for General Microbiology's autumn meeting at the University of Nottingham's Jubilee Campus.

The research is aiming to uncover the make-up of Parkinson's disease by studying the protein alpha-synuclein in yeast cells.

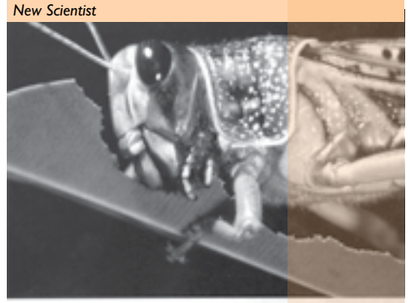
Dr Outeiro said: "Yeast is a very simple but powerful model in which to study how alpha-synuclein actually works as, remarkably, many of the biochemical pathways involved are similar between yeast and humans.

"There is still a lot we don't know about the function of this protein, but we do know that even small increases in the level of alpha-synuclein in cells lead to cell death."

The conference will also hear about Finland-based Dr Helena Rintala's work studying the possible benefits of household microbes.

She said: "We spend more than 90 per cent of our lives in indoor environments and breathe the indoor air, so it is important to know the environment is healthy."

New Scientist



Insect brains outsmart hospital superbugs

Professor Howard Jenkinson from the University of Bristol also had more than his 15 minutes of fame. His talk on oral streptococci that can escape into the blood stream and initiate blood clots was the basis for articles on BBC online as well as in the *Telegraph*, the *Mirror* and the *Express*. Howard also did interviews for the Radio 4 *Today* programme, BBC Radio Bristol and Radio 5 Live *Drive*. We thought SGM had also better grab a quick interview and an SGM podcast with Howard is now available to listen to on our website.

PhD student, Gavin Bingley from Manchester Metropolitan University presented his work on fungal degradation of archived cine film; a slightly more unusual story that sparked interest from the BBC and the *New York Times* amongst others.

Mirror

Mouth bugs link to clots

BACTERIA that gets into the bloodstream via bleeding gums can trigger deadly clots, scientists have discovered.

The bugs give out a protective protein that forces platelets to bind together to shield themselves with clots.

Study leader Professor Howard Jenkinson, of Bristol University, told the Society for General Microbiology: "This could lead to new treatments for cardiovascular diseases, which is the biggest killer in the developed world."

Sniff, sniff... pass the tissues as blood test spells end of man flu

Daily Telegraph

Why brushing your teeth can help you live longer

By Victoria Fletcher Health Editor

Express

● **A BUG'S LIFE:** Our cinematic history is under threat from fungi living off film reels, it was revealed yesterday. The microbes are not only degrading films but the spores they release 'could also be considered a health risk', said Gavin Bingley from Manchester Metropolitan University. His research team is hoping to develop a sensor that will detect whether the mould is living or not to prevent archivists throwing away reels of film that pose no danger to human health.

Metro

The *Telegraph* took a great angle in their reporting of a talk from Dr Aimee Zaas from Duke University in the US about a new diagnostic tool for respiratory viral infections. Their headline: '*Sniff, sniff… pass the tissues as blood test spells end of man flu*' quite probably caused concern among some of the male population!

All the media releases can be seen on our website at **www.sgm.ac.uk/news/media_releases.cfm**

LAURA UDAKIS, PRESS AND PUBLIC AFFAIRS ADMINISTRATOR

Social media update

FACEBOOK

Over 1,100 *Facebook* users are now connected to the SGM page and are kept regularly up-to-date with all our events and publications. It's also great to see an increasing number of users interacting with the page – through comments, 'likes' and posting content themselves.

TWITTER

Twitter went down a storm at the SGM Autumn Conference, where the tag **#SGMnotts10** allowed delegates (and us!) to post our comments on the sessions, events and even the lunch! *Twitter* was a great way of receiving feedback from delegates and will definitely be back at the Spring Conference 2011.

You can follow us on Twitter by searching for **SocGenMicro**

PODCASTS

The SGM podcasts have been re-launched! Follow the link on the news pages of the **SGM website** (www.sgm.ac.uk) or **microbiologyonline** (www.microbiologyonline.org.uk) to hear Professor Howard Jenkinson and Dr Steve Kerrigan talking about their latest research on oral streptococci that can 'jailbreak' into the circulation and initiate the formation of blood clots.

JULY COUNCIL MEETING HIGHLIGHTS

MARLBOROUGH HOUSE BUSINESS

Marlborough House staff said their goodbyes to **JANET HURST** and **RICHARD NOBLE** with a little sparkling refreshment to lubricate the process! At the same time, several new recruits to Marlborough House were welcomed: **DR DAVID EYRE** and **DAVID BRADLEY** as Staff Editors, **DR VICKI SYMINGTON** as Education and Outreach Administrator and **DR KAREN MCGREGOR** as Member Services and Grants Administrator.

As mentioned in the previous report, **DR RON FRASER**, SGM's Chief Executive Officer, will retire in July 2011. An appointments subcommittee of Council has been set up to oversee this process and a recruitment agency, Perrett Laver, engaged. The subcommittee has met with the agency's consultant and a timetable was developed, with the post being advertised in mid-September. The consultant has also met with SGM staff to ascertain their views.

Three Council members retire in September: **PROFESSOR MIKE BARER**, **DR RICHARD HALL** and **DR CATHERINE O'REILLY**. The President thanked them for their contributions during their time on Council. Two new Council members were elected unopposed: **PROFESSOR JOHN SINCLAIR** (University of Cambridge) and **PROFESSOR NIGEL BROWN** (University of Edinburgh) – see p. 206 for profiles of the new members.

Council unanimously supported Professor Harwood's nomination of **JANET HURST** for honorary membership of the Society, for her innovative contribution to the advancement of microbiology, particularly in regard to outreach and education activities, personally and through her team.

Like the majority of learned and professional societies, membership of SGM is declining slightly. In order to investigate the reasons, to identify how new members can be recruited and retained, and to determine how the SGM's international membership might be expanded, a subcommittee chaired by **DR GARY ROWLEY** has been set up, and has already met to discuss the way forward. The first steps will be to conduct a membership survey, led by **DR JANE WESTWELL**, and to convene a focus group of early-career microbiologists to discuss what they would like from Society membership.

Implementation of a new membership and meetings database system was progressing. Marlborough House staff short-listed four potential suppliers who would make presentations in July and August. A software consultant was engaged to facilitate the process; at the time of writing the preferred supplier has been identified and the contract negotiated. The main computer server will be renewed to cope with the new system. Tied into these upgrades will be the updating of SGM's main website.

PRESIDENT'S BUSINESS

PROFESSOR LAPPIN-SCOTT opened with a discussion on how to develop and improve relations with other microbiological societies. Examples given were the Society for Applied Microbiology (SfAM) and the American Society of Microbiology (ASM).

A paper prepared by **DR PAUL HOSKISSON** on the provision and future of microbiological culture collections was discussed. Council complimented his efforts. The three aspects covered were: (i) what expertise is lacking for full taxonomic investigations and how should the data from newer methods be integrated with existing data; (ii) how can we move towards a structured system to cope with accumulating biological data; and (iii) how can we ensure the validity of published species descriptions, verify published data and ensure availability of materials? Council concluded that the subject could form the focus of a debate at the Spring Conference in Harrogate.

Professor Lappin-Scott also requested that SGM begin to review the costs of meetings and mechanisms to do so were initiated.

GENERAL SECRETARY'S REPORT

The recipient of the next SGM Prize Medal lecture was identified and will be invited to receive their prize and give the lecture at the Spring Conference in Harrogate. The name of the recipient will be announced in due course.

The General Secretary would attend the forthcoming Council meeting of the Federation of European Microbiological Societies (FEMS) in Prague in September.

TREASURER'S REPORT

The Society continues to remain financially healthy thanks to its significant reserves and investment portfolio and despite continued market volatility. Income for 2010 remains satisfactory.

SCIENTIFIC MEETINGS OFFICER'S REPORT

PROFESSOR CHRIS HEWITT presented a summary of the review of the new meetings structure. Approximately 3,500 delegates attending SGM conferences over the last 4 years were polled and 360 responded. Selected highlights included:

- 83% of those expressing a preference rated the new meetings structure as good, very good or excellent.
- Three-quarters preferred to stay in guesthouses and hotels rather than in university accommodation.
- 97% rated speaker quality as good, very good or excellent.
- 57% preferred to start at 09.00 rather than 08.30.

Professor Hewitt recognized the value of the meeting review and the popularity of the new meeting structure, but commented that we should not become complacent. Therefore, he proposed that similar reviews of meetings should take place every 2 years. His review committee recommended the filming of certain conference lectures so that they could be provided as webcasts and podcasts for members. Webcasts of the four prize lectures given at the Spring Conference at the Edinburgh International Conference Centre are now available through the SGM website at **www.sgm.ac.uk/meetings/**

The organization of forthcoming conferences in Autumn 2010 (Nottingham), Spring 2011 (Harrogate) and Autumn 2011 (York) was in order. Plans were under way to hold the Spring 2012 Conference at the International Conference Centre in Dublin, recognized that year as European City of Science.

EDUCATION AND PUBLIC AFFAIRS OFFICER'S REPORT

PROFESSOR JO VERRAN commented on the continued growth and popularity of schools membership, reflecting the value of the training and educational resources provided by the Society. She also acknowledged SGM's vigorous outreach activities, organized by **DARIEL BURDASS** and **LAURA UDAKIS** and supported by a number of Marlborough House staff. For example, the Society had been highly visible at the recent Cheltenham Science Festival, running three events: (i) a hands-on interactive event exploring the good and bad side of food microbes; (ii) a debate on the pros and cons of using genetically modified organisms; and (iii) a drama, *Stopping the Spread of Superbugs* (see p. 236), addressing the risks and processes contributing to infections in hospital.

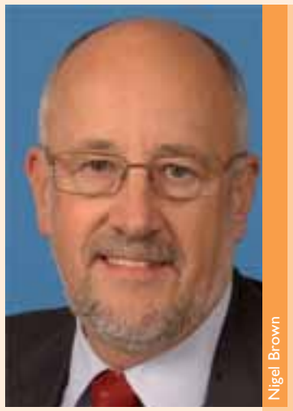
PUBLICATIONS OFFICER'S REPORT

PROFESSOR HOWARD JENKINSON noted that the impact factors of the SGM journals were in general increasing; the efforts of the Editors-in-Chief in this regard were noted with thanks by Council. Professor Jenkinson also explained that a subcommittee would undertake a review of various aspects of the journals and would report to Council in November.

DAVID BLACKBOURN, GENERAL SECRETARY

NEW MEMBERS OF COUNCIL

PROFESSOR NIGEL BROWN


Nigel Brown

Nigel Brown started his research career in Biochemistry at the University of Leeds working on bacteriophage in *Myxococcus*. Following a postdoc with Fred Sanger at the MRC Laboratory for Molecular Biology, he moved to Bristol, first as a Lecturer in Biochemistry and then as a Royal Society Senior Research Fellow. In those early days of DNA sequencing and gene cloning his lab had a 'machine tools division', isolating new restriction enzymes alongside his work on antimicrobial resistance and transposition in bacteria.

A year's sabbatical at the University of Melbourne provided new projects and a liking for Australian wine, both of which he took with him to Birmingham in 1988, where, as Professor of Molecular Genetics and Microbiology, he was Head of Biological Sciences and subsequently Head of Chemistry. His research focused on bacterial interactions with metals, metal-dependent gene regulation and the MerR regulator family. He was Chief Editor of *FEMS Microbiology Reviews* from 2000 to 2004, and oversaw a rise in impact factor from 6.4 to 10.0.

In 2004, he became BBSRC Director of Science and Technology, with responsibility for science strategy and grants, and for liaison with universities, Government departments and other funders. In 2008, he was appointed Vice-Principal and Head of the College of Science and Engineering at Edinburgh. In addition to his membership of SGM Council, Nigel is inter alia a member of the Scottish Science Advisory Council, of the ESF Life and Environmental Sciences Committee, and of the ERANet SysMO Science Advisory Board.

Nigel is married with 3 daughters and a slowly increasing number of grandchildren.

PROFESSOR JOHN SINCLAIR


John Sinclair

John Sinclair is the Professor of Molecular Virology in the Department of Medicine at the University of Cambridge. His PhD studies, at the University of Essex (1978–1981) were on the molecular biology of slime mould differentiation. After this, he carried out postdoctoral studies at the University of Sussex (1981–1986) and was then appointed as a non-clinical lecturer in the Departments of Medicine and Virology (Royal Postgraduate Medical School, Hammersmith Hospital). In 1987, he moved to the University of Cambridge and was awarded a personal chair in 2005.

Professor Sinclair's research interests are in the molecular biology and pathogenesis of human herpes viruses, particularly human cytomegalovirus (HCMV). HCMV is a major cause of disease in transplant patients and patients with AIDS, and his research programme aims to understand latency and reactivation of this persistent human virus and how the host immune response combats virus disease.

As well as being a member of the Society for General Microbiology, Professor Sinclair is a member of the American Society for Microbiology. He is also an Editor of *Journal of General Virology* and an Editorial Board Member for *Journal of Virology*.

News of Members

Congratulations

PROFESSOR DR BERNHARD SCHINK, Department of Biology, University of Konstanz, Germany, assumed the presidency of the Federation of European Microbiological Society (FEMS) on 25 September, following the 37th FEMS Council Meeting in Prague, Czech Republic. He was elected to the post a year before to succeed former FEMS President Dr Milton da Costa from Portugal.


Professor Dr Bernhard Schink


Dr Robin May

DR ROBIN MAY, School of Biosciences, University of Birmingham, has been awarded the 2010 Lister Institute of Preventive Medicine Research Prize. These prizes, worth £200,000, are awarded to outstanding young researchers in biomedical or related biological sciences to support research over a period of 5 years. The funding will be used to continue Dr May's research into the yeast *Cryptococcus neoformans*, the causative agent of cryptococcosis, a fatal disease of immunocompromised patients.

DR CAROL IVERSEN, Microbiological and Molecular Analytics, Nestlé Research Centre, Lausanne, Switzerland, has been chosen by the American Society for Microbiology (ASM) to receive a 2010 ICAAC Young Investigator Award for her work re-classifying the taxonomy of *Enterobacter sakazakii*, which led to the creation of a novel genus *Cronobacter*. In 2008, Dr Iversen led the organization of the 1st International Conference on *Cronobacter* which attracted more than 200 delegates.


Dr Carol Iversen

Deaths

The Society notes with regret the deaths of **DR ROGER BERKELEY** (member since 1962), a former Committee Member of the SGM Cell Surfaces & Membranes Group (1975–1979) and SGM Meetings Secretary (1980–1985), **DR A.S. BEARE** (member since 1962), **PROFESSOR CECIL CUMMINS** (member since 1951) and **DR ANTHONY MORAN** (member since 1983).

STAFF

KAREN MCGREGOR has recently been appointed to the Meetings and Membership Services team where she has taken over the administration of the grants programmes from Jane Westwell. She will also be responsible for a range of member services, particularly career development activities. These will include attending careers fairs to promote careers in microbiology and the benefits of SGM membership, and revamping the SGM careers website (**www.biocareers.org**). Karen will be drawing on her own experiences of undergraduate study and a PhD (The University of Western Australia), two postdoctoral positions (University of Dundee and Imperial College London) and a Senior Lectureship (University of West London) to provide advice and support on career development for microbiologists at all stages of their career. When not working to support microbiologists in their endeavours, Karen is an avid reader, keen cook and amateur crocheter.


Karen McGregor. *Laura Uddkis*

Congratulations…

… to *Journal of General Virology* Senior Staff Editor **NATALIE WILDER** and her husband James on the birth of their second child, Eloise May, on 8 October 2010 – a sister for their little boy Alex who is now 2 years old.


Steven Wilder

PRIZES

Celebrating early-career microbiologists at Nottingham

Delegates gathered at SGM's Autumn Conference in Nottingham to see six early-career microbiologists compete for the *Sir Howard Dalton Young Microbiologist of the Year* competition. They were nominated by the Divisions on the strength of their research presentations (either poster or oral) at a previous SGM conference. As in other years, there was a high standard of talks. The winners of of the £500 (Nabil Wilf), £200 (Robert Valentine) and £100 prizes (Shailesh Jain) were announced at the conference dinner. All six contestants will receive 1 year's free membership of SGM.


Education & Public Affairs Officer, Joanna Verran, presenting Microbiology Outreach Prize winner Gemma Walton with her certificate. *Ian Atherton*


Contestants taking a welcome breath of fresh air after the competition. *Back row*: Shailesh Jain, Caroline Wright & Karen Tomkins. *Front row*: Marijke Frederix, Nabil Wilf & Robert Valentine. *Jane Westwell*

If you would like to enter the *Young Microbiologist of the Year* competition in 2011, make sure you submit an abstract for the Harrogate Conference, or Irish Division Meeting, and indicate your interest in being considered.

After the competition presentations, delegates were treated to an entertaining talk by *Microbiology Outreach Prize* winner Gemma Walton about her experiences of engaging a wide variety of audiences in her research area of gut microbiology. In addition to her achievement, Gemma should be congratulated on her repertoire of (polite) synonyms to describe gas release!

Nominations are now invited for the 2011 *Microbiology Outreach Prize* (sponsored by Yakult UK Ltd). Full details are available from **www.sgm.ac.uk/PA_forms/OP2011.doc**

SGM has a wide range of grant schemes to support microbiology.
See www.sgm.ac.uk for details. Enquiries should be made to: **Grants Office, SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG** (**tel.** 0118 988 1807; **fax** 0118 988 5656; **email** grants@sgm.ac.uk)

Student schemes

Infection Training Support Grants

Funding for infection trainees (during foundation or specialty training) to carry out short lab-based projects on a microbiological topic. The grant covers a contribution towards consumables costs only. Closing dates: **18 MARCH** and **23 SEPTEMBER 2011**.

Scientific Meetings Travel Grants

This scheme is open to a range of early-career microbiologists resident within the EU, from postgraduate students through to first postdocs and newly appointed lecturers. Funding is tiered according to the location of the meeting. The maximum grants are: UK (or country of residence) – **£200**; within Europe – **£350**; Rest of World – **£500**. These grants may also be used to support attendance on short courses.

President's Fund for Research Visits

Grants are available to support short research visits (1–3 months) by early-career microbiologists resident within the EU, ranging from postgraduate students through to first postdocs and newly appointed lecturers. Funding is limited to a maximum of £3,000. Retrospective applications will not be accepted. Closing dates: **18 MARCH** and **23 SEPTEMBER 2011**.

Hayes–Burnet Travel Award

A limited grant of up to £3,000 is available to present work at the annual meeting of the Australian Society for Microbiology (ASM) and make a short research visit of up to 3 weeks at a laboratory in Australia. This scheme is offered jointly with the ASM and supports the reciprocal exchange of one postgraduate student member to present their research at the other society's main conference and to visit a research lab in that country. Closing date: **11 FEBRUARY 2011**.

A similar scheme, the Heatley–Payne Award, has been set up with the American Society of Microbiology. Watch out for the next closing date to be announced in 2011.

Elective Grants

Funding for medical/dental/veterinary students to work on microbiological projects in their elective periods. Closing dates for applications in 2011 are **19 MARCH** and **24 SEPTEMBER**.

Vacation Studentships

The 2011 scheme is now open for applications. The scheme offers a great opportunity for undergraduates to work on microbiological research projects during the summer vacation before their final year. The awards, which are made by competition, aim to give students experience of research and to encourage them to consider a career in this area. The studentships provide support at a rate of £185 per week for a period of up to 8 weeks. An additional sum of up to £400 for specific research costs may also awarded. Applications must be from SGM members on behalf of named students. Closing date: **20 FEBRUARY 2011**.

Student Conference Grants

Grants contribute towards travel, registration and accommodation expenses for attendance at one SGM conference each year. Applicants must be Postgraduate Student Associate Members resident and registered for a PhD in an EU country, or Undergraduate Members based at a university in the UK or Ireland accepted to present work at the conference. Closing date for Harrogate Conference: **8 APRIL 2011**.

Several undergraduate students came to the 2010 SGM Spring Conference and enhanced the experience gained from their vacation studentships, or other projects, by presenting their work alongside other researchers in the poster sessions. We are hoping to welcome even more students to Harrogate.


Aaliya Somani, *University of Westminster*


Claire Colenutt, *University of Exeter*


Christopher Harte, *University of Reading*


Karen McKenzie, *University of Strathclyde*

Some of the undergraduates who presented posters at the Spring 2010 Conference. *Janet Hurst/Laura Udakis*

Student Society Sponsored Lectures

These cover the travel and other expenses of up to two speakers on microbiological topics per Society each year at student society meetings.

Other schemes

Public Engagement with Science Awards

Are you planning any projects to promote the public understanding of microbiology? Have you got a National Science & Engineering Week event in mind? SGM can help. Grants of up to £1,000 are available to fund appropriate activities. Applications are considered on a first come, first served basis throughout the calendar year.

SGM membership subscriptions 2011

The following rates were agreed at the AGM of the Society on 7 September 2010.

Membership category	Annual subscription		Additional subscriptions for publications (print only)							
			Microbiology		*JGV*		*IJSEM*		*JMM*	
	£	US$	£	US$	£	US$	£	US$	£	US$
Ordinary	57	110	112	220	112	220	112	220	70	140
Associate Postgraduate Student Associate Retired Associate	25	52	52	100	52	100	52	100	52	100
Undergraduate	10	NA	NA	NA	NA	NA	NA	NA	NA	NA
School Corporate	15	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corporate	Tier 1	350	NA	NA	NA	NA	NA	NA	NA	NA
	Tier 2	500	NA	NA	NA	NA	NA	NA	NA	NA

For airmail despatch of *Microbiology Today*, add £20/US$36 to subscription.

Members are reminded that their 2011 subscriptions are due for payment by **1 December 2010.**

As in previous years, no journal or meetings information will be despatched to members who are in arrears, and there will be no guarantee of provision of back numbers of journals for members who pay their subscription late.

PAYMENT AGAINST INVOICE

Invoices were despatched recently to all members who pay by this method. If you did not receive one, please inform the Membership Office.

SECURE ONLINE CREDIT CARD RENEWAL PAYMENT

If you pay against invoice, you can renew your subscription online via the SGM website (**www.sgm.ac.uk/members**) with either a credit or debit card. Please see your invoice for details.

PAYMENT BY DIRECT DEBIT

Subscription notices were despatched recently to all members paying by direct debit. To continue your present status and journal requirements, no further action is necessary. To change your membership status or journal requirements for 2011 you should have amended your subscription notice and returned it to the membership office by **12 November 2010**. However if you have missed this deadline, your amended notice will be accepted if it is submitted immediately.

Please note

Continuous credit card payments are no longer available. Alternative methods are by direct debit (for UK bank account holders) or one-off credit/debit card payment online.

INCOME TAX RELIEF ON MEMBERSHIP SUBSCRIPTIONS

Members who are liable for UK income tax are reminded that their annual subscriptions to the Society have been approved by the HMRC as qualifying for income tax relief. Any member who would like further information or has difficulty in obtaining this relief should contact the Chief Executive (r.fraser@sgm.ac.uk).

The bacterial ‘nose’

Known to be the cause of many pungent smells themselves, bacteria are also capable of olfaction, according to a recent study. Researchers at Newcastle University have discovered that bacteria are able to detect small, smelly, air-borne chemicals such as ammonia.

The soil bacteria *Bacillus subtilis* and *Bacillus licheniformis* were able to respond to ammonia in the air by forming biofilms. The response decreased the further apart the two bacterial colonies became. The work has important implications for understanding how biofilms are formed and how they could potentially be manipulated. The authors believe this could be the first example of how living creatures learned how to smell other creatures and say their next step is to identify the ‘nose’, or sensor, that does the smelling.

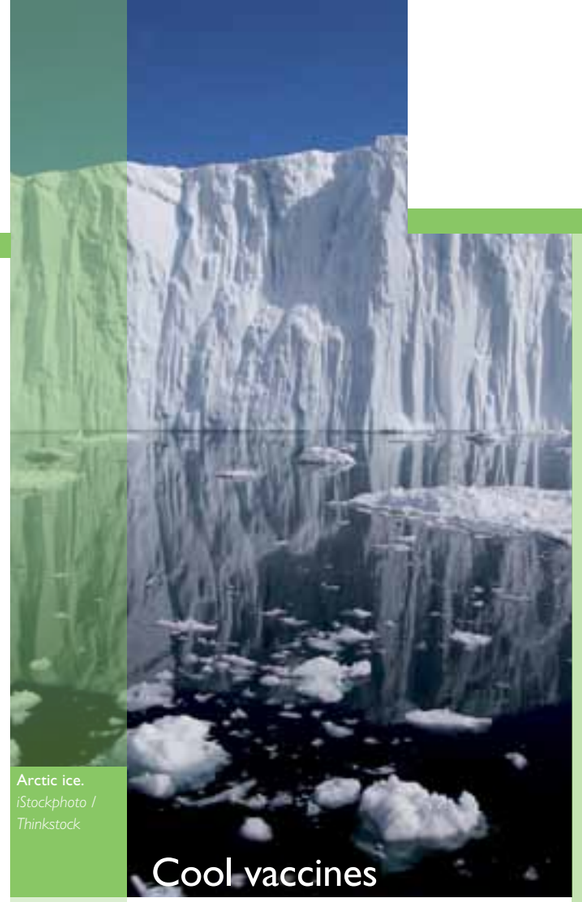
Journal of Biotechnology **doi:10.1002/biot.201000174**

Comstock / Thinkstock

Proceeding with caution

When pathogenic bacteria that spread over organ tissues detect antibiotics on the horizon, they freeze in their tracks and only continue when the threat subsides. Researchers from the Universitat Autònoma de Barcelona (UAB) showed that *Salmonella enterica* stopped its collective movement – known as swarming – when concentrations of antibiotic were detected by outer cells of the swarm. The scientists found that the antibiotic was able to activate the SOS response in bacteria, which increased the concentration of RecA. This protein, which is involved with the bacterial DNA repair mechanism, interferes with CheW – essential for bacteria motility – causing the bacteria to stop in their tracks. When the antibiotic concentration was reduced, cellular levels of RecA decreased, allowing CheW to do its job facilitating the movement of the bacteria once again. The researchers believe that the findings could allow for the design of agents that block RecA and thus increase antibiotic sensitivity of bacteria.

Infection and Immunity **doi:10.1128/IAI.01321-09**



Arctic ice. *iStockphoto / Thinkstock*

Cool vaccines

Genes from arctic bacteria could form the basis of effective vaccines for diseases such as TB, according to scientists. Researchers at the University of Victoria in British Columbia, Canada replaced essential genes in *Francisella tularensis* with those from bacteria living at extreme sub-zero climates. The essential genes stop functioning at warm temperatures, allowing the bacteria to survive in skin tissues where they can provoke an immune response, but not in warmer internal organs where they may cause disease. Mice that were injected in their tails with the modified bacteria were able to survive subsequent doses of wild-type *F. tularensis* that would normally be fatal. The scientists are now hoping to use the method to create a successful vaccine against TB.

Proceedings of the National Academy of Sciences U S A **doi:10.1073/pnas.1004119107**

iStockphoto / Thinkstock

Microbial ‘tea’-shirts

An unexpected link between microbiology and fashion has been revealed by scientists at Imperial College London: a new fabric, created from long filaments of cellulose produced by bacteria. The material is produced by *Acetobacter* bacteria that are grown in a vat of green tea, sugar and other nutrients over several days. The microbes produce long, thin strands of cellulose that clump together to form thin mats on the surface of the mix. Once dried, the material has a leather-like texture, but is extremely lightweight. It has already been used to create jackets, shirts, dresses and even shoes.

The scientists, who have been collaborating with fashion designers from Central Saint Martins College of Art and Design, believe that such sustainable fabrics could be increasingly important as resources for traditional fabrics such as cotton, wool and leather become more difficult to come by.

http://antenna.sciencemuseum.org.uk/trashfashion/home/wearwithoutwaste/material-desires/biocouture-jacket/

Soybeans. *USDA ARS*

Fungal sunscreen

Protecting fungus with a sunscreen could make it more effective against insects that attack food crops. *Beauveria bassiana* is a promising biological control agent that poses little risk to humans, animals and beneficial insects. Its spores can be sprayed onto crops in a liquid, which after germination can infect and kill a range of destructive insect pests. The spores, however, are susceptible to sun damage. Scientists from the US Department of Agriculture’s Agricultural Research Service have tried to solve this problem by combining molecules of soybean oil with ferulic acid to create a UV-absorbing, protective ‘soyscreen’. The fungal spores survived well in the oil-based formulation and most importantly were successfully protected from degradation when exposed to sunlight. The work was presented at the American Chemical Society’s National Meeting and Exposition.

http://portal.acs.org/portal/acs/corg/content

When the going gets tough… the tough get unstuck!

Family deaths are always traumatic, but *Caulobacter crescentus* reacts in a rather unusual way. When close relatives in a biofilm die, surviving cells lose their stickiness. Scientists from Indiana University found that extracellular *Caulobacter* DNA, released from dying cells, prevents neighbouring cells from adhering to surfaces. This allows bacteria to escape from biofilms to somewhere where conditions may be better. Biofilms are generally advantageous to bacteria – equipping them with resistance to predators and antibiotics amongst other things – but if conditions take a turn for the worse, it becomes beneficial for bacteria to escape from the established colony. However, the bacterial ‘glue’ that allows cells to collectively adhere to surfaces is so strong that there is no escape from the biofilm once stuck. *Caulobacter* get around this predicament by spawning daughter cells with flagella, giving them the option of swimming away from the parent cell (and the biofilm) if the going gets tough. The researchers believe that a product of cell death may be used as a marker of environmental conditions, allowing daughter *Caulobacter* cells to decide whether they stick within the biofilm or take their chances and break free. Such a mechanism seems quite logical, according to the authors of the paper who point out that if your siblings are starting to die around you, it’s a good indicator that it’s a good time to find somewhere else to live!

Molecular Microbiology **doi:10.1111/j.1365-2958.2010.07267.x**

FUTURE IRISH DIVISION

Autumn 2011
University of York
5–7 September 2011

Spring 2011
Queen's University Belfast, 19–20 April 2011
Microbial viruses: genomics, evolution and applications in ecology, biotechnology and medicine
Organizer: Dr Leonid Kulakov

Autumn 2011
University College Cork
Marine biotechnology

For details of all Irish Division activities, contact John McGrath (j.mcgrath@qub.ac.uk)

OTHER EVENTS

SGM is supporting the following meetings:

Federation of Infection Societies
17–19 November 2010
Edinburgh International Conference Centre
www.fis2010.co.uk

Genetics, Biochemistry and Molecular Biology of Archaea
University of St Andrews, 6–7 January 2011

European Society of Clinical Virology
Institute for Child Health, London, 13–15 January 2011
www.escv.org/meetings/meetings.asp

Antibiotics 2011 – Where Now?
Burlington House, London, 20 January 2011
www.rsc.org/ConferencesAndEvents/RSCConferences/Antibiotics2011/index.asp
SGM members can register for this meeting at the discounted RSC member rate. To take advantage of this offer, contact **j.westwell@sgm.ac.uk** *to obtain registration promotional code.*

Fighting Infections: Challenges & Recent Progress
Bergen, Norway, 26–28 May 2011

FEMS 2011 – 4th Congress of European Microbiologists – Advancing Knowledge on Microbes
Geneva, Switzerland, 26–30 June 2011
www2.kenes.com/fems2011/Pages/Home.aspx

SCIENTIFIC MEETINGS COMMITTEE

- **Scientific Meetings Officer**
  Professor Christopher J. Hewitt
  c.j.hewitt@boro.ac.uk
- **Deputy Scientific Meetings Officer**
  Dr Evelyn Doyle
  evelyn.doyle@ucd.ie
- **Education Division**
  Dr Sue Assinder
  s.assinder@liverpool.ac.uk
  Dr Sara Burton
  s.k.burton@exeter.ac.uk
- **Eukaryotic Microbiology Division**
  Professor Neil Gow
  n.gow@abdn.ac.uk
  Dr Peter Sudbery
  p.sudbery@sheffield.ac.uk
- **Irish Division**
  Dr John McGrath
  j.mcgrath@qub.ac.uk
  Dr Kevin Kavanagh
  kevin.kavanagh@may.ie
- **Prokaryotic Microbiology Division**
  Dr Ian Henderson
  i.r.henderson@bham.ac.uk
  Dr Nick Dorrell
  nick.dorrell@lshtm.ac.uk
- **Virology Division**
  Professor Mark Harris
  m.harris@leeds.ac.uk
  Dr Paul Duprex
  p.duprex@qub.ac.uk
- **Chief Executive**
  Dr Ron Fraser
  r.fraser@sgm.ac.uk
- **Head of Meetings and Membership Services**
  Dr Jane Westwell
  j.westwell@sgm.ac.uk
- **Scientific Conferences and Events Manager**
  Susan Leonard
  meetings@sgm.ac.uk
  tel. 0118 988 1832;
  fax 0118 988 5656

Suggestions for topics for future symposia are always welcome.

WWW.SGM.AC.UK/MEETINGS — DELIVERING MODERN MICROBIAL SCIENCE

SPRING CONFERENCE 2011

11–14 APRIL 2011

WWW.SGMHARROGATE2011.ORG.UK

Plan to attend for a fantastic programme covering a broad range of microbiological themes. Take the opportunity to hear experts and join in scientific exchange at Europe's largest annual gathering of microbiologists and virologists.

Scientific Sessions
Intracellular life | Seeing the cell through the 'eyes' of the virus | Social evolution in micro-organisms | Mechanisms of DNA repair | Microbial PAMPs | Life at zero growth rate | Vaccines | Meningitis | Osmotic & oxidative stress responses | Food biosecurity | Insect symbiosis | Microbes & maths

Workshops
Pathogenesis | Replication & gene expression | Structural virology | Cell-to-cell transmission | Vaccines & antivirals | Working with the media
Plus Welcome workshop and supper for early-career delegates.

Also featuring
SGM Prize Medal Lecture
Fleming Prize Lecture
Colworth Prize Lecture

Early-career Microbiologists
We offer great opportunities to our early-career delegates. In addition to the lively poster sessions, there are slots for offered oral papers throughout the scientific programme. We hope you will take the opportunity to practise your presentation skills in the friendly environment of the Spring Conference.

Sir Howard Dalton Young Microbiologist of the Year Competition
Selection for a place in the finals of the *Sir Howard Dalton Young Microbiologist of the Year* Competition takes place in Harrogate. If you want to be considered – and are a postgraduate student or postdoctoral scientist, who has gained your PhD in the last 2 years – you should tick the relevant box on the abstract submission form.

CALL FOR ABSTRACTS

Play an active part in the SGM Spring Conference 2011 by submitting an abstract via our online system.

Deadline for submissions: 14 January 2011.

Grants
Conference grants are available to all SGM Associate Members who are Postgraduate Students or Technicians, and to Undergraduate Members who are presenting work at the conference.

Welcome Workshop & Supper for Early-career Delegates
We will kick-off the conference on **Sunday 10 April 2011** with an event aimed at first-timers (although all early-career delegates are welcome to attend). Jo Heaton, from the Education & Training Division, will host an evening of fun activities to improve your communication skills and add value to your conference experience.

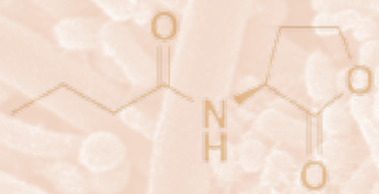
Registration
Registration fees include; refreshments, lunch, drinks receptions, abstracts CD, exhibition entry and all conference literature. Specially discounted rates are available for SGM Associate/Postgraduate Student Associate Members.

Registration couldn't be easier: Either register directly online at **www.sgmharrogate2011.org.uk** or complete (and return) the downloadable PDF.

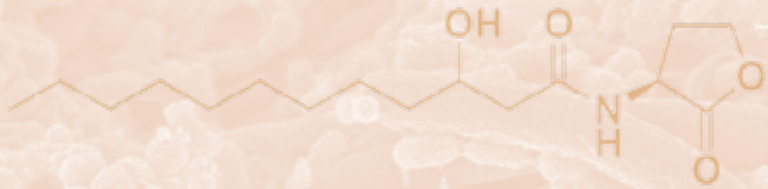
Earlybird registration deadline: 4 March 2011.

CPD
Approved by the Royal College of Pathologists and the Institute of Biomedical Science. Up to 25 points available. Also approved by the Society of Biology for purposes of CPD, this event may be counted as 70 CPD credits.

CONFERENCES



AHL signal molecule C4-HSL



AHL signal molecule 3-OH-C12-HSL

STEVE ATKINSON

Microbial community chat

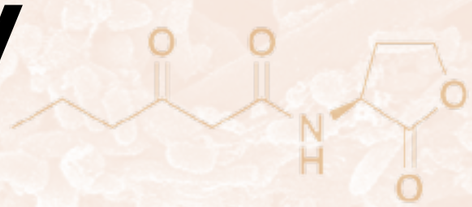
Coloured scanning electron micrograph of bacteria in dental plaque, an example of a microbial community. *S. Gschmeissner / SPL*

WHEN THE FIRST BACTERIA were observed with a microscope, it must have been something of a leap of faith to believe they were living organisms, let alone consider that they were not behaving as individuals, but were in fact co-operating in a coordinated community where cell-to-cell communication plays an integral part in their life cycle. As early as 1905, Erwin Frink Smith, in his manuscript *Bacteria in relation to plant disease* was astute enough to comment that '*a multiple of bacteria are stronger than a few*', but it was not until the early 1990s that the concept of bacterial cell-to-cell communication actually gained credence within the microbiological community with the discovery that bacteria employ chemical signals (pheromones) to communicate, and so coordinate population-wide behaviour with changes in environmental conditions. The concept of bacterial cell-to-cell signalling, usually referred to as quorum sensing (QS), has now been observed in a wide variety of Gram-positive and Gram-negative plant and animal pathogens, including those responsible for important human diseases. It is also noteworthy that QS systems are not limited to prokaryotes, but have also been described in eukaryotes such as yeast.

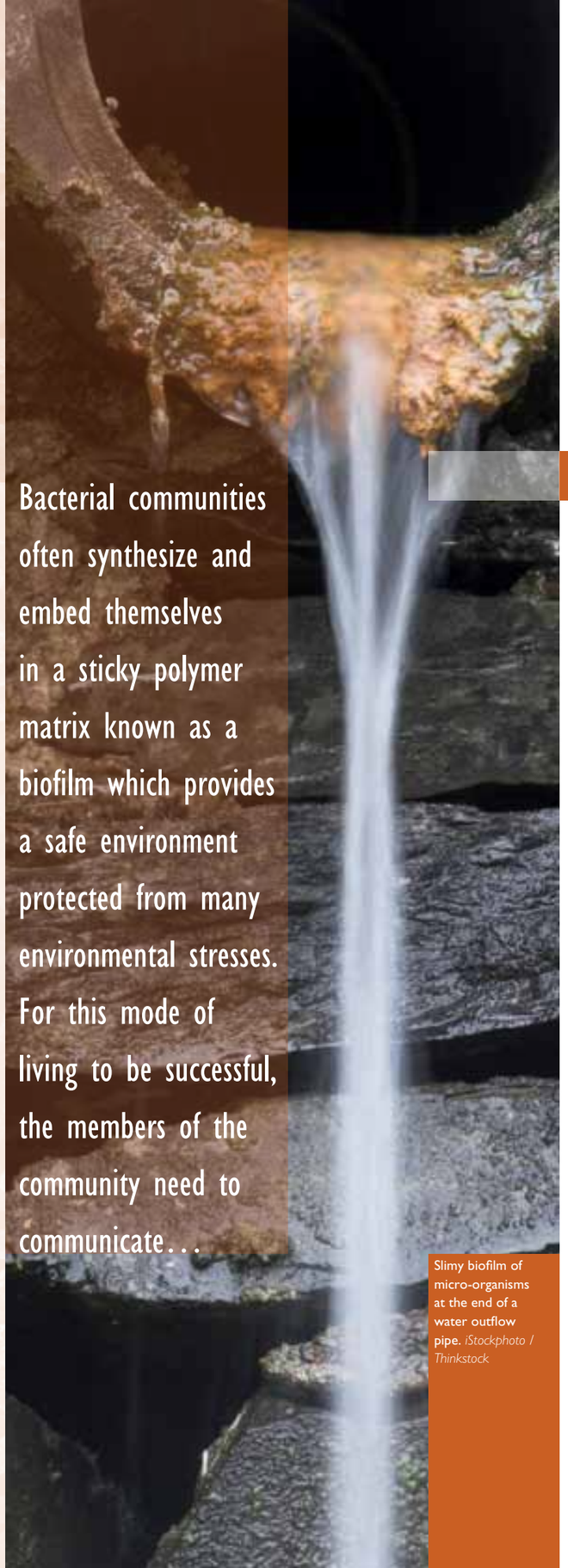
The basic concept which underpins QS is the notion that under a given set of conditions, (for example temperature, pH, the presence of a host cell, etc.) a bacterial population will synthesize signal molecules, and upon reaching the appropriate population density the concentration of the signal (which will vary as a function of signal production and turnover) will be sufficiently high to switch on the appropriate response for the prevailing conditions. Given that the concentration of the signal and number of individuals in the population synthesizing the signal are intrinsically linked, there is likely to be an exponential increase in both signal concentration, and ultimately the response, and for this reason the term autoinduction is often used when describing QS systems. Signal diversity is observed among different bacterial species, and it is also evident that QS signals/systems are present in some eukaryotes. The signalling pathways are not limited to bacterial interspecies communication, but are also commonplace between species and even kingdoms.

N-ACYL HOMOSERINE LACTONE (AHL)

For the purpose of this article we will concentrate on the AHL signals synthesized by Gram-negative bacteria. AHLs are composed of a homoserine lactone ring with a fatty acyl side chain which can vary in length from 4 to 18 carbons. QS signals do not act alone, but instead work in tandem with a response regulator (RR) which will bind to the signal, and in combination the signal/RR complex will trigger the appropriate response. QS was first described in *Vibrio fischeri*, a marine symbiont which can be found free-living in the sea or enclosed in the light organs of some fish and squid. In the latter, the symbiotic relationship provides *V. fischeri* with a nutrient-rich environment and in return the bacteria provide the host with the ability to bioluminesce. The



AHL signal molecule 3-oxo-C6-HSL



Bacterial communities often synthesize and embed themselves in a sticky polymer matrix known as a biofilm which provides a safe environment protected from many environmental stresses. For this mode of living to be successful, the members of the community need to communicate...

Slimy biofilm of micro-organisms at the end of a water outflow pipe. *iStockphoto / Thinkstock*

"It has been estimated that up to 80% of all bacterial infections seen in the clinic are biofilm-associated."

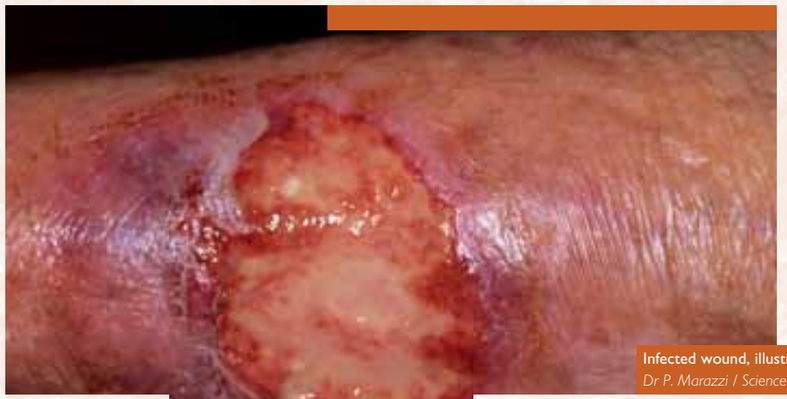
V. fischeri AHL signal is synthesized by a protein (AHL synthase) known as LuxI, encoded by the *luxI* gene. The AHL concentration increases in line with an increase in the bacterial population density until the signal reaches a threshold level at which point the AHL binds to the RR protein LuxR (encoded by the *luxR* gene). The AHL/LuxR complex then triggers the production of the proteins necessary for the production of bioluminescence. QS systems are not limited to regulating bioluminescence – they also regulate a number of important processes, including those relating to virulence in plant and animal pathogens, and include the production of exoenzymes, exotoxins, motility, conjugation, aggregation and notably in this context biofilm formation.

BIOFILMS

Bacterial communities have been found in almost every habitat on earth and their resilience is often attributed to their ability to produce and embed in a sticky extracellular polymer matrix composed of exopolysaccharides, proteins and extracellular DNA known as a biofilm. For a live example, stop reading for a minute and go and stick your finger down the kitchen plug hole or drain and then come back and carry on reading…

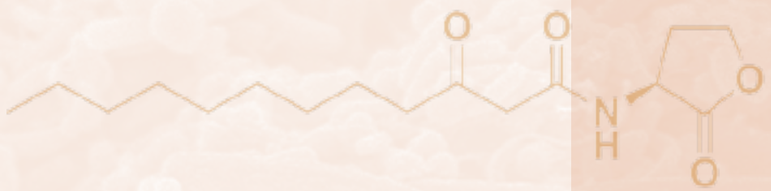
The slime which you have just encountered is a biofilm. Biofilms have been described as slime cities in which mushroom-shaped columns of bacteria (microcolonies), embedded in an extracellular matrix rise up between channels which provide the necessary access for water, nutrients and signals to reach all the members of the community. The bacteria which reside in biofilm communities are highly tolerant to environmental challenge, which ensures that the population is able to thrive in even the harshest conditions. The majority of bacterial infections are, at some point in their life cycle, associated with persistent biofilms, with chronic wounds being particularly susceptible. This poses a considerable problem in the clinic, since biofilm-dwelling bacteria are often highly refractory to treatment with antibiotics. Infection may then result in long-term hospitalization and significant patient trauma, and may lead to surgery which itself incurs a high risk of re-infection. Biofilms are also problematic in industrial processing plants, and are of particular concern in the food-processing and pharmaceutical industries. There may be considerable cost issues associated with preventing or removing biofilms from a processing plant, along with the obvious health risks associated with the contamination of products.

Divisions of labour are commonplace in biofilm communities with the bacteria at the periphery of the microcolony behaving differently to those embedded deep inside. Such community cohesion requires tight regulation of the individuals which reside within, and also requires that the members of the population are spatially 'aware' of their own location in the community and the whereabouts of other members. For such a coordinated community to exist there has to be communication between the individuals which make up the population, and over the last few years it has become evident that QS and the formation, maturation and dispersal of biofilm communities are intrinsically linked. A considerable amount of work detailing the links between biofilms and QS has been performed using the opportunistic human pathogen *Pseudomonas aeruginosa*, but this work relates to the production of biofilms on inert, non-living (abiotic) surfaces such as plastic and glass. However, to conceptualize QS-associated biofilm community existence in a model system in which a living (biotic) surface is studied, and is therefore relevant to infection, we have been examining biofilm formation using the enteropathogen *Yersina pseudotuberculosis* and the nematode worm *Caenorhabditis elegans* as model organisms. We are beginning to understand the relationship that exists between QS and biofilms in these two organisms and the complex regulatory mechanisms which underlie this relationship.



Infected wound, illustrating how important biofilms are in the clinic.
Dr P. Marazzi / Science Photo Library

AHL signal molecule 3-oxo-C12-HSL



C. ELEGANS AND *Y. PSEUDOTUBERCULOSIS*

C. elegans is commonly found in soil water, and being small (a fully developed adult is usually ~1 mm long) it has proved to be a tractable model as it is easy to culture in the laboratory where it grows rapidly on widely available, inexpensive growth media if it is supplied with a bacterial food source on which it can graze. The *C. elegans* genome was the first to be sequenced from an animal and it is now evident that many of its genes share considerable homology to mammalian counterparts, including those found in humans, making this organism an attractive model for research into prokaryote–eukaryote interactions.

Y. pseudotuberculosis is a pathogen which infects mammals, including humans, if contaminated food or water are consumed. Symptoms range from stomach cramps, nausea, vomiting and diarrhoea through to terminal ileitis and reactive arthritis, and symptoms may be severe in immunocompromised, very young or very old individuals. *Y. pseudotuberculosis* has a well-defined QS system in which a pair of AHL synthases (called YpsI and YtbI) are responsible for the synthesis of four major AHLs. Signal transduction in *Y. pseudotuberculosis* is mediated by two response regulators, namely YpsR and YtbR, and taken together the system regulates flagella-mediated motility and a form of cell aggregation in which clumps of biofilm-dwelling bacteria are suspended in liquid. The complexity of the system is highlighted by the fact that two AHL synthase/RR pairs control two distinct processes using several different AHLs.

When *C. elegans* is supplied with *Y. pseudotuberculosis* as a food source, a biofilm accumulates around the mouth and anterior end of the nematode, preventing it from feeding effectively. While it is widely accepted that the maturation of biofilms which form on abiotic surfaces are often QS-dependent, whether QS plays a role in biofilm formation on biotic surfaces was unknown. In light of the relationship between *Y. pseudotuberculosis* and *C. elegans*, my colleagues and I reasoned that the key to successful biofilm formation on a living surface was probably an effective AHL signal-mediated communication system between the bacteria. We therefore genetically modified *Y. pseudotuberculosis* in order that the bacteria would fluoresce green when viewed under a laser scanning confocal microscope if AHL signal molecules were present in the developing biofilm. Green fluorescent bacteria were indeed

Caenorhabditis elegans.
Sinclair Stammers / Science Photo Library

clearly visible embedded in the biofilm (itself stained with a biofilm-specific fluorescent red dye) surrounding the worm head. Although AHLs were present in the biofilm, these data did not reveal a specific role for QS in the biofilm developmental process and we therefore went further and made genetic mutations to render *Y. pseudotuberculosis* incapable of producing AHLs. In this case, *Y. pseudotuberculosis* biofilm formation was severely curtailed, revealing a clear link between bacterial cell–cell communication and biofilm formation on a living surface.

We are now in a position to expand our initial observations and examine in more detail how a developing biofilm-dwelling community of *Y. pseudotuberculosis* coordinates the production of biofilm on a living surface. Given that it has been estimated that up to 80% of all bacterial infections seen in the clinic are biofilm-associated, we hope to develop our QS/biofilm biotic surface model with a view to further understanding how disrupting the signalling pathways associated with virulence can reduce biofilm-associated infections, either directly by reducing the ability of the bacteria to form normal biofilms or indirectly by making biofilms more susceptible to antibiotics and host defences.

STEVE ATKINSON is a Senior Research Fellow, School of Molecular Medical Sciences, University Park, University of Nottingham (email steve.atkinson@nottingham.ac.uk)

FURTHER READING

Atkinson, S. & Williams, P. (2009). Quorum sensing and social networking in the bacterial world. *Interface* 6, 959–978.

Atkinson, S., Cámara, C. & Williams P. (2007). The role of *N*-acylhomoserine lactones in biofilm formation. In *Bacterial Biofilm Formation and Adaptation*, pp. 95–122. Edited by M. Givskov & S. Kjelleberg. Norwich: Horizon Scientific Press.

Atkinson, S., Sockett, R.E., Cámara, M. & Williams, P. (2006). Quorum sensing and the lifestyle of *Yersinia*. *Curr Issues Mol Biol* 8, 1–10.

Quorum sensing website: www.nottingham.ac.uk/quorum

Seaweed on rocks. *iStockphoto / Thinkstock*

Social interactions in a unicellular world

STEVE DIGGLE & ROMAN POPAT

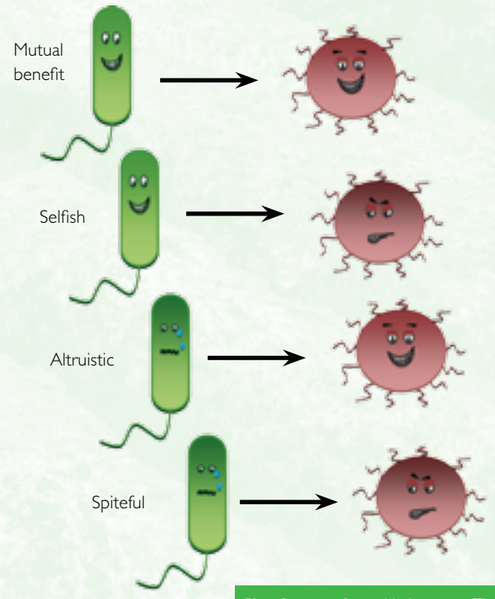
Increasingly, it is being realized that bacteria communicate and co-operate to perform a wide range of social behaviours. Traditionally, research in this area has been performed at the molecular level and less attention has been paid to evolutionary and ecological factors which govern such actions. What is the relevance of social evolution for microbes?

MOST OF US at some point have had the rather unpleasant experience of putting our fingers down a plug-hole only to pull up a slimy goo. As microbiologists are now well aware, this is a large mass of microbial cells that we commonly refer to as a biofilm, and such microbial communities can be found almost everywhere. They are the pioneers of rocky shores which help enable seaweed to settle on rocks. They cause problems in industrial settings such as contamination of beer lines. Clinically, they are of huge importance, contributing to infection, colonization of medical devices and antibiotic resistance. Biofilms consist of numerous cells, often belonging to a number of diverse species surrounded by a complex exopolysaccharide matrix. They remind us that bacterial cells interact with each other and inevitably lead social lives. Recently, there has been a growing interest in studying aspects of sociality using bacteria or other microbial study systems.

WHAT IS A SOCIAL BEHAVIOUR?

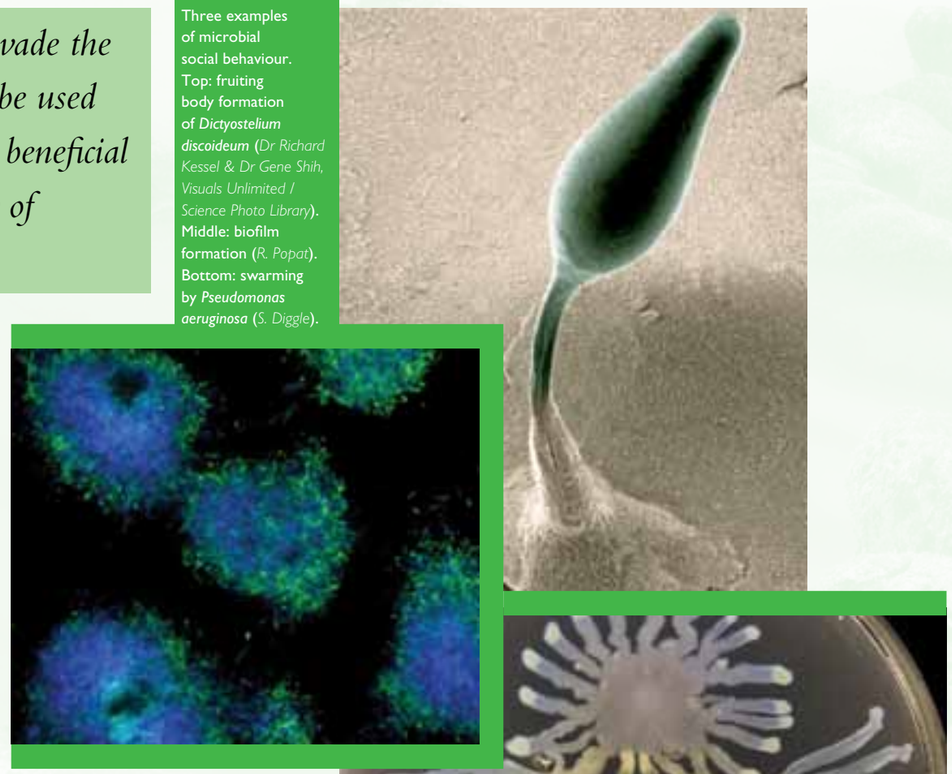
You do not have to look far to observe social behaviours in nature; they span the entire tree of life from microbes to man. A social behaviour is one that has fitness consequences for both the actor performing the behaviour and the recipient. For example, during a winter storm in Antarctica, when an Emperor penguin moves from the outside of a huddle to the inside, he warms himself, but exposes one of his neighbours. If this behaviour affects the reproductive success (*fitness*) of the two penguins, then it can be considered a social behaviour. Social behaviours can be classified into four categories: mutual benefit, selfishness, altruism and spite – distinctions between them are based on the fitness effects on the actor and recipient. All altruistic and some mutually beneficial behaviours involve co-operation. A co-operative trait is any that increases the fitness of an individual other than the actor and that has evolved at least in part because of this effect. It is necessary to make distinctions between social behaviours in order to help us identify behaviours that evolve and are maintained very differently. For example, it is relatively easy to see how mutually beneficial behaviours and selfishness evolve because they increase the fitness of the individual performing them. Charles Darwin's theory of natural selection can be viewed as maximization of individual fitness. However, altruism and spite are different – they decrease the fitness of the actor!

A classic example of altruism is the sterile worker castes of eusocial insects such as ants or bees. If the sterile workers never have the opportunity to reproduce and pass on their genes, how do successive generations still contain them? Sterile worker bees and ants commit evolutionary suicide by not reproducing and instead working to help the reproduction of others. An analogous situation in the microbial world is fruiting body formation by the amoeba *Dictyostelium discoideum*. During fruiting body formation, approximately 20% of cells lyse, producing a strong cellulosaic structure that supports the spore-forming



Classification of social behaviours. The class of behaviour is determined by the fitness effects on the actor (green) and recipient (red). *S. Diggle*

"If cheating cells can invade the population, they could be used as a vehicle to deliver a beneficial allele directly to the site of infection."



Three examples of microbial social behaviour. Top: fruiting body formation of *Dictyostelium discoideum* (*Dr Richard Kessel & Dr Gene Shih, Visuals Unlimited / Science Photo Library*). Middle: biofilm formation (*R. Popat*). Bottom: swarming by *Pseudomonas aeruginosa* (*S. Diggle*).

cells. Whilst this might be viewed as altruistic behaviour, it is important to note that altruism can be more sinister. Spite could be considered the evil twin of altruism. A number of bacterial species produce bacteriocins, toxins designed to kill or harm other bacteria. The toxin-producing strain is usually immune, but able to kill unrelated cells around it. Sometimes the producing strain commits suicide, lysing itself to release the bacteriocins and paying the ultimate price. Altruism and spite are similar in that both, via different mechanisms, increase the fitness of surrounding relatives.

A major problem with co-operative behaviours is the potential exploitation by social cheats or freeloaders. Most microbes rely on secreted factors to modify the local environment outside the cell and obtain nutrients. These factors are often termed 'public goods', a term widely used in economics. For example, *Pseudomonas fluorescens* forms floating biofilms at the air/liquid interface of a liquid culture. It floats because it produces a secreted polymer and therefore gains access to favourable oxygen levels. Sometimes a mutation causes one of the cells to stop producing the polymer. This 'cheat' now has a fitness advantage, it can still stick to the biofilm, but saves energy on polymer production which it can divert into reproducing itself. Cheats are able to spread in the population, outgrowing the polymer-producers and cause the whole biofilm to sink back down into the anoxic liquid. Such public goods co-operation and cheating is common in microbes. Any secreted factor (and microbes produce plenty) that is beneficial to its producer and neighbouring cells is vulnerable to cheating.

Darwin's original theory does not satisfactorily explain the evolution and maintenance of such co-operative behaviours and so extensions to the founding logic are required.

POST-DARWINIAN SOLUTION

Darwin himself struggled with the idea that organisms of any kind would perform a behaviour that decreased their fitness or solely increased the fitness of another. He framed the problem like this:

'*If it could be proved that any part of the structure of any one species had been formed for the exclusive good of another species, it would annihilate my theory, for such could not have been produced through natural selection*' (from *On the Origin of Species*, Chapter 6: Difficulties on Theory).

Evolutionary biologists have worked feverishly in the years since Darwin to try to explain this apparent conundrum. Many solutions have been proposed and different social behaviours have different evolutionary explanations. If you want to know more, please see the further reading list below. Here, we will just focus on one that is likely to be important in microbes.

It was discovered in the 1960s that unselfish co-operation that results in a cost to the actor can be inherited when it is directed towards other individuals which will reciprocate. In other words, co-operation is favoured when the benefits accrue to related individuals that share the genes for co-operation (*kin selection*). There are many documented examples of this in nature. Some bird species upon failure to mate successfully or locate a partner will return to the nests of relatives to help them rear their young. Wild turkey males team up with related individuals to perform mating displays more noticeable to females than a solo dance, even though only one of the suitors is successful. It has been demonstrated in bacteria that high relatedness selects for co-operative traits such as iron scavenging, biofilm formation and quorum sensing (QS)-dependent virulence factor production. Indeed, it is a compelling explanation for the ultimate sacrifice made by stalk-forming or lytic bacteriocin-releasing cells.

In order for kin selection to operate, however, individuals need to direct co-operation towards others that share the genes for co-operation. Some birds simply remember which nest is theirs and therefore reduce the chance of feeding unrelated offspring; other organisms locate kin by sight and smell which gives an estimate of how similar the genomes are. In species where a co-operative trait like breeding requires many genes to act in concert, overall genetic relatedness, such as familial relations, provides a reliable indication of whether or not neighbours will co-operate. Since most microbes are clonal or asexual, the need to recognize relatives is less. If daughter cells are identical to parents and do not disperse far, then neighbours are likely to be related. For example, many microbes live in biofilms which contain pockets or microcolonies of highly related clone-mates. In addition, a single gene can be responsible for co-operation in microbes, so overall genetic relatedness is not a good indicator of the likelihood your neighbours will co-operate. The shape of 'kin recognition' in microbes is therefore more likely to be a gene for gene recognition. These types of genes have been identified in higher organisms and are often referred to as greenbeard genes. An example of a greenbeard in microbes can be found in *Saccharomyces* in which the *Flo1* gene is responsible for the production of a cell-wall protein allowing cells to flocculate or clump together. This clumping together provides protection from the stresses of the environment. Because the Flo1 protein product binds Flo1 proteins on other cells to create the clump, cells not expressing Flo1, non-co-operative cells, are excluded from the clump. Another possible way that microbes can increase relatedness is to mobilize the co-operative trait on a plasmid. A bacterium surrounded by cheats could transform them into kin by transferring a plasmid encoding the co-operative trait.

EXPLOITING SOCIAL EVOLUTION

Decades of work on the molecular and cellular mechanisms of microbial behaviour have produced a richness of information, but in many instances the adaptive nature of the behaviour is less well understood. By combining both molecular and evolutionary approaches, we can expand our understanding of microbial social behaviour, the ultimate goal being the refining of disease control strategies. A great number of pathogens rely on public goods such as toxins and enzymes to gain access to the host. Many studies have shown that bacterial pathogens which are unable to produce toxins are less virulent in hosts. Can we turn this to our advantage?

Recently, it has been shown that infections of mice and humans with the generalist pathogen *Pseudomonas aeruginosa* are less virulent when QS cheater cells are present. This is because the cheats have fitness benefits and outgrow the co-operators. They do not contribute to public goods production and therefore virulence, causing a detriment to the bacterial population, but increasing the survival rate of the host. Other recent experiments have shown that bacteriocin competition between infective strains of *P. aeruginosa* also reduces the virulence of an infection. Bacterial cells waste energy killing each other whilst increasing the survival of the host. Is there potential to exploit this therapeutically? There is a potential benefit in introducing avirulent cheating cells into existing antibiotic-resistant infections. If the cheating cells can invade the population, they could be used as a vehicle to deliver a beneficial allele directly to the site of infection. This type of therapy would have three main advantages: (1) the presence of cheats themselves should reduce virulence; (2) cheats are an effective way of delivering a secondary treatment to the site of infection; and (3) cheats could reduce the antibiotic resistance of an infection.

From blocked sinks to severe antibiotic-resistant infections, the challenges of living with microbes are great and long-lasting. By understanding infections at a population level as well as at the level of the cell, we can expand our armoury against them and learn interesting new things about social evolution in general.

STEPHEN P. DIGGLE & **ROMAN POPAT** are from the School of Molecular Medical Sciences, University Park, University of Nottingham (email steve.diggle@nottingham.ac.uk; mrxrp1@nottingham.ac.uk).

FURTHER READING

Buckling, A., Maclean, C.R., Brockhurst, M.A. & Colegrave, N. (2009). The *Beagle* in a bottle. *Nature* 457, 824–829.

Diggle, S.P., Griffin, A.S., Campbell, G. & West, S.A. (2007). Cooperation and conflict in quorum sensing bacterial populations. *Nature* 450, 411–414.

Nadell, C.D., Xavier J.B. & Foster, K.R. (2009). The sociobiology of biofilms. *FEMS Microbiol Rev* 33, 206–224.

Rumbaugh, K.P., Diggle, S.P., Watters, C.M., Ross-Gillespie, A., Griffin A.S. & West, S.A. (2009). Quorum sensing and the social evolution of bacterial virulence. *Curr Biol* 19, 341–345.

Strassmann, J.E., Zhu, Y. & Queller, D.C. (2000). Altruism and social cheating in the amoeba *Dictyostelium discoideum*. *Nature* 408, 965–967.

West, S.A., Griffin, A.S., Gardner, A. & Diggle, S.P. (2006). Social evolution theory for microorganisms. *Nat Rev Microbiol* 4, 597–607.

Williams, P. (2007). Quorum sensing, communication and cross-kingdom signalling in the bacterial world. *Microbiology* 153, 3923–3938.

See Steve Diggle's forthcoming article in Microbiology *(vol. 156, part 12) based on the text of his Fleming Prize Lecture delivered at the Society's Spring 2010 Conference in Edinburgh.*

When the sequence of the first bacterial genome was published in 1995, no one could have predicted how sequencing technology and data analysis would evolve over the next decade and a half. Techniques will soon be available to determine and compare many sequences at once, and the enormous amount of data soon to be generated will bring exciting new insights into how micro-organisms within communities evolve and interact.

Stockphoto / Thinkstock

Covering all the bases with next-generation sequencing

REGARDLESS of the species in question, announcements of completed genome sequencing projects in the mainstream media almost invariably make reference to 'cracking a code' or 'deciphering a genetic blueprint'. For bacteria, these over-used analogies spectacularly fail to give a true sense of the fluidity of genome evolution. The doe-eyed assumption in the mid-1990s that a single genome sequence can safely be considered as a prescriptive 'solution' for a given bacterial species has been dramatically falsified. By the late 1990s, multiple genome sequences for *Escherichia coli* revealed extensive differences in gene content between strains, and it rapidly became clear that, for many taxa, an individual genome is most usefully considered as one of many possible combinations of genes drawn from a vast pool known as the pangenome. When faced with such a maelstrom, our natural inclination (as good cladists) is to try and tidy it up, and catalogue strains into pockets of relatedness. Fortunately, phylogenetic analyses are possible, even for very variable species like *E. coli*, because one can readily identify genes which are universally present in all strains. These essential 'core' genes can be thought of as representing the operating system of a given species. In contrast, the specialist software is provided by 'non-core' or 'accessory' genes which are variably present or absent, are commonly acquired by horizontal transfer, and tend to be restricted to hypervariable regions called genomic islands. These two sets of genes present a fundamental duality in bacterial genomics. Whilst core genes can satisfy our requirements for molecular phylogeny (i.e. what a strain *is*), accessory genes often play a significant role in adaptation and phenotypic differences (i.e. what a strain *does*). Conflicts between these two can go a long way to explaining the mystery behind the muddle that is bacterial systematics.

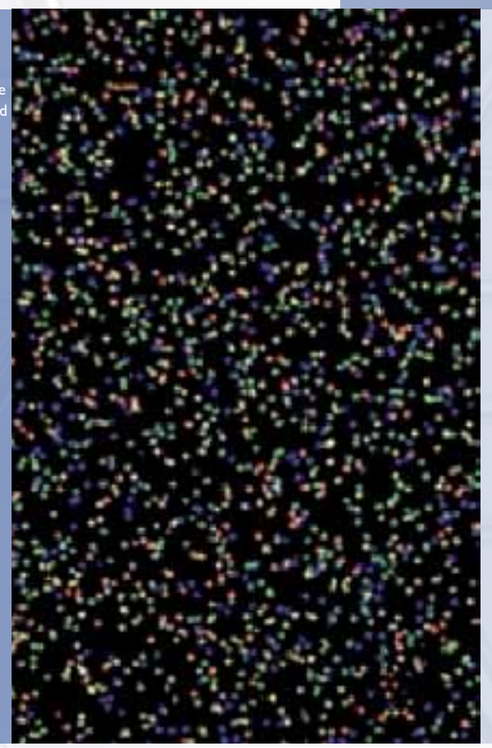
THE NEW WAVE

The distinction between population genetics and comparative genomics is fundamentally technological rather than conceptual. Until recently, it has not been possible to generate genome-wide data for large population samples (hundreds of strains). For this reason, small samples of core genes have been used in many population studies, an approach epitomized by multilocus sequence typing (MLST) which typically utilizes seven core genes. However, the advent of next-generation sequencing platforms, currently the Solexa Illumina Genome Analyser (IGA), Roche 454 and SOLiD systems, potentially provide the means to detect the vast majority of single nucleotide polymorphisms (SNPs) in hundreds of query strains relative to a reference sequence. As this technology, and associated bioinformatics software, becomes more routine and accessible, so we should be braced for the next major wave of molecular data for bacteria. Importantly, these datasets represent far more than MLST writ large, and it

"As this technology, and associated bioinformatics software, becomes more routine and accessible, so we should be braced for the next major wave of molecular data for bacteria."

is timely to consider the opportunities they will afford with respect to the population and genomic dynamics over extremely short time scales.

As was the case with MLST, and for obvious reasons, this new technology is initially being applied to bacterial pathogens (e.g. *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Clostridium difficile*). The motivation of these early projects overlaps with the aims of previous population studies, in that they seek to describe the extent and distribution of natural variation (population structure), and to ultimately understand the roles of migration, demography, recombination, selection and drift in shaping this structure. A clear advantage afforded by the new technologies is massively increased resolution. Isolates which are identical by MLST can be readily distinguished, and this provides the ability to focus on changes within isolates previously assigned as belonging to a single strain. It is certain that the ability to assay changes occurring over months or years will reveal strong geographical structuring, even within species which are currently considered to be globally homogenized. This will allow the detection of specific transmission events with a high degree of confidence, both on intercontinental and local scales, and we will begin to build up a more complete understanding of the patterns of movement in both pathogenic and environmental species. For nosocomial pathogens, it may even be possible to reconstruct transmission routes within single healthcare settings, which would have clear implications for infection control. Although much of the local variation detected will be neutral, it is likely that these datasets will eventually also reveal evidence of local adaptation. For example, in a clinical context such adaptations may reflect local antibiotic usage, whilst in an environmental context phage might be an important driver of local adaptation.



The Illumina platform works by first binding fragments of DNA onto a surface. As free bases are incorporated into these fragments different coloured flashes of light are recorded, and short sequences for each fragment are read by building up a series of images. The figure represents a montage of all four bases. *Ed Feil*

"For nosocomial pathogens, it may even be possible to reconstruct transmission routes within single healthcare settings, which would have clear implications for infection control."

SHEDDING LIGHT ON MUTATION

Next-generation sequencing is also set to shed light on the basic evolutionary processes of recombination and mutation. The precise mapping of recombination events across a genome will not only provide evidence concerning overall recombination frequency within a population (which is typically the best we can manage currently), but also specific data on tract lengths, recombination hotspots and patterns of gene flow between different lineages. There are equally exciting opportunities for studying patterns of mutation. Reconstructing the *de novo* mutational profile is problematic because selection can operate quite rapidly to remove deleterious mutations, potentially even in sites traditionally considered neutral. Although this problem decreases as one compares ever more closely related genomes (because selection will have had less time to compromise the mutational footprint), the paucity of changes at very close distances leads to statistical difficulties. The availability of genome-wide data for large numbers of isolates representing only a few years or months of divergence will provide the means to robustly compare mutational patterns between lineages, and to detect which mutation types are in general most likely to be deleterious. Occasional adaptive mutations can also be identified on the basis that these are more likely to be homoplasic. These data will also provide more accurate evidence concerning mutation rates in different lineages, the emergence of hypermutation in natural populations, and a greater understanding of how mutation rates in general appear to slow down as one moves from the tips of the tree, due to the removal of slightly deleterious changes. It is essential to incorporate this latter effect when dating the emergence of specific clones, or reconstructing demographic changes.

EXCITING TIMES

The questions above focus on core SNPs detected by mapping sequence reads to a previously sequenced reference genome, a procedure that excludes those accessory genes or elements present in the query strains but absent in the reference. There are two ways to overcome this limitation. First, as the genomic datasets expand, it will be possible to construct a pangenome database containing all the known genes for a given species to be used in lieu of a single reference genome. Second, as read lengths increase and software improves, the *de novo* assembly of unmapped reads will become more feasible. This means that it should be possible to reconstruct a complete gene inventory for each query strain, even if many of the genes are absent in the reference genome. Although problems may remain in assigning precise genomic locations to these assembled elements, the approach will at least facilitate detailed study of the evolution and dissemination of horizontally acquired genes of particular phenotypic relevance (e.g. antibiotic resistance cassettes). It will also be possible to construct a more general overview of the relative stability of different types of elements, and the functioning and regulation of horizontally acquired genes within different genomic contexts. Ultimately, this new era of population genomics promises a much more complete synthesis between molecular, population and ecological processes.

Exciting times lie ahead.

EDWARD J. FEIL is a Reader in Microbial Evolution at the Department of Biology and Biochemistry, University of Bath, Bath BA2 7AY (tel. 01225 383021; fax 01225 386779; email e.feil@bath.ac.uk)

FURTHER READING

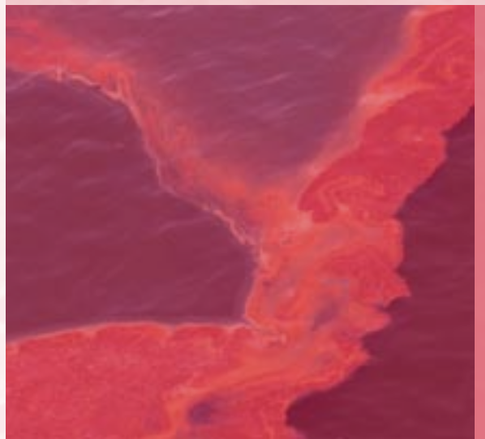
Harris, S.R., Feil, E.J., Holden, M.T.G. & others (2010). Evolution of MRSA during hospital transmission and intercontinental spread. *Science* 327, 469–474.

He, M., Sebaihia, M., Lawley, T.D. & others (2010). Evolutionary dynamics of *Clostridium difficile* over short and long time scales. *Proc Natl Acad Sci U S A* 107, 7527–7532.

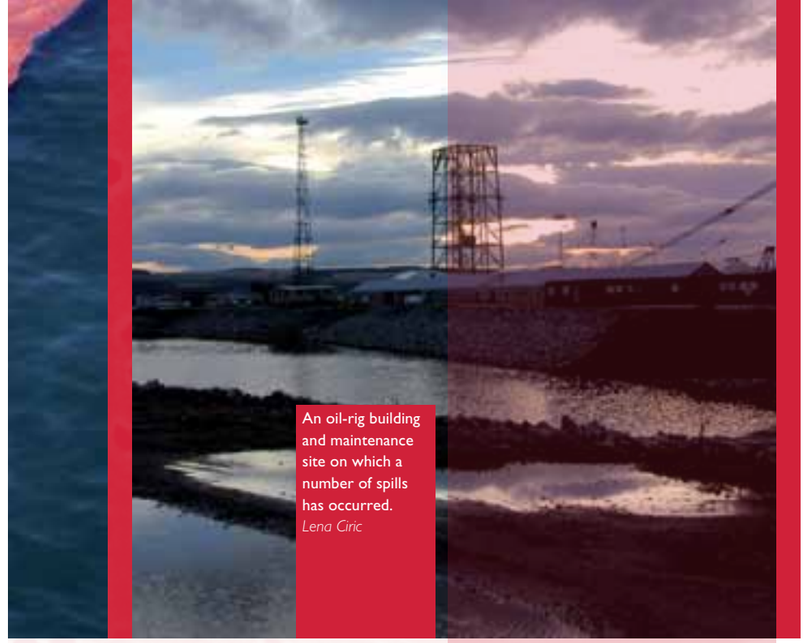
Maiden, M.C., Bygraves, J.A., Feil, E. & others (1998). Multilocus sequence typing: a portable approach to the identification of clones within populations of pathogenic microorganisms. *Proc Natl Acad Sci U S A* 95, 3140–3145.

A tide of oily water heads towards the Florida coast after the explosion of the *Deepwater Horizon* rig in the Gulf of Mexico. *Jim Edds / Science Photo Library*

A natural solution: how bacterial communities can help clean up oil spills



LENA CIRIC



An oil-rig building and maintenance site on which a number of spills has occurred. *Lena Ciric*

ON 20 APRIL 2010, a massive explosion rang out in the Gulf of Mexico. The source of the incident was the *Deepwater Horizon* drilling rig, situated about 84 km from the Louisiana coast, which had been drilling for oil at a depth of over 1,500 m. The explosion killed 11 people at the time and was the cause of what is now referred to as the worst environmental disaster in US history. It is difficult to state the exact volume of oil which has spilled into the Gulf of Mexico, the best estimate being put forward by the US government as 4.9 million barrels. That's over 770 million litres, or over 300 full Olympic-size swimming pools!

The well which was the source of the oil spill has since been plugged successfully and a US government report has stated that three-quarters of the spilled oil as now been 'dealt with'. A considerable proportion of the removal of the spill is attributed to bacterial biodegradation of the hydrocarbons that constitute the crude oil. The huge oil spill in the Gulf of Mexico is only one of a huge number of oil spills that have taken place over the course of Earth's history. For billions of years, our microbial neighbours have been evolving to utilize the molecules that constitute oil – and it turns out that they have now become quite good at it.

MICROBIAL DEGRADATION OF HYDROCARBONS

Crude oil is composed of many different kinds of hydrocarbons: from the paraffins, which are solid waxy substances in their pure form, to gases and everything in between. The molecules come in various shapes and sizes: some are formed of rings of carbon atoms (aromatic compounds) and some of chains (aliphatic compounds). As a general rule, the higher the number of rings or links in the chain, the more difficult a molecule is to degrade. On the other hand, the lower or shorter the number of rings or links, the more toxic the compound is to microbes. However, for the great majority of these structures, toxic or not, there is a bacterium out there which is capable of metabolizing the compound to a new structure. Crude oil is very carbon-rich – more than 80% carbon –

Headlines around the world this year have been dominated by the explosion on an oil-drilling rig off the southern coast of the USA, and the subsequent environmental catastrophe that followed. Communities of bacteria have evolved over billions of years to be rather better than we are at breaking down the complex hydrocarbons that are found in oil. How we can exploit this ability to improve our future clean-up strategies?

The contents of a tank used as part of a treatment system for oil-contaminated groundwater. The oil can be seen as a layer on top of the water. The swirls seen at the interface of the oil and water are bacterial flocs which are metabolizing hydrocarbons. *Lena Ciric*

"For billions of years, our microbial neighbours have been evolving to utilize the molecules that constitute oil – and it turns out that they have become quite good at it. More often than not, researchers have found whole bacterial communities capable of degrading the constituents of crude oil in a particular location, rather than just individual species."

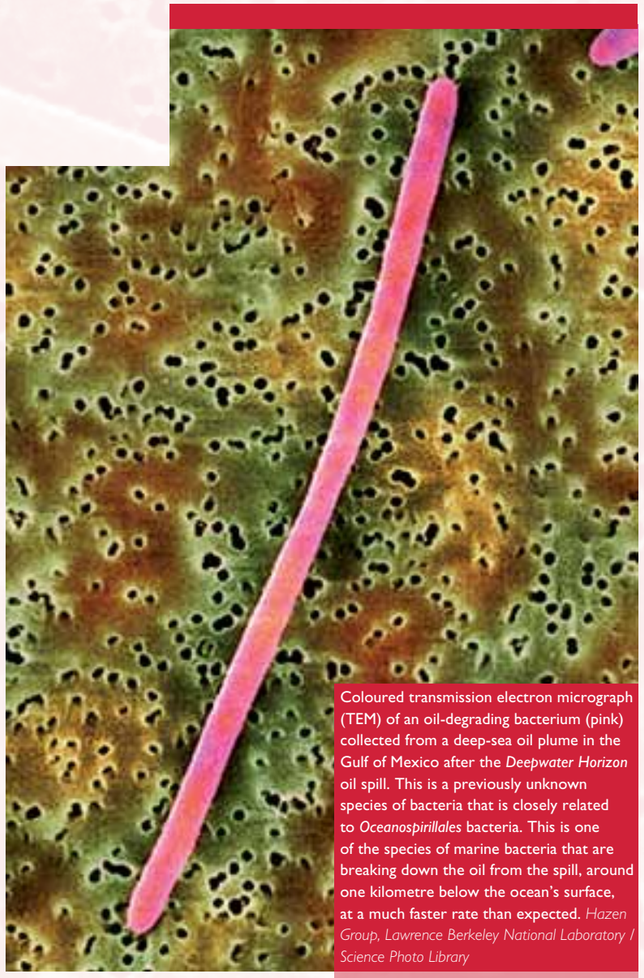
which makes it a great energy source for the microbial community.

Microbial degradation of hydrocarbons was first recorded towards the end of the 19th century. The various processes involved have been studied since, but in particular since the 1970s when the oil boom took place and oil spills became a more common occurrence. The possibility that bacteria could be used as a quick, easy and cheap clean-up strategy for oils spills is very appealing and has attracted both public and private funding.

Bacterial species possess a wide variety of enzymes which allow them to exploit this carbon-rich energy source. These include alkane hydroxylase (involved in the breakdown of aliphatic compounds) and catechol dioxygenase (involved in the breakdown of catechol – a metabolite of aromatic compound degradation). These enzymes are found in a large number of different species, and although the gene sequence encoding the enzymes can vary, the resulting protein sequence and enzyme structure, and therefore function, remains consistent. Enzymes which enable bacteria to metabolize hydrocarbons can often be located on mobile genetic elements, which allow the genes to transfer more easily between different species.

A huge number of species have been found which are capable of degrading hydrocarbons. Some have even been named as a consequence of their degrading capabilities, such as *Pseudomonas oleovorans* (literally oil-devouring unit), *Mycobacterium pyrenivorans* (pyrene-devouring small rod), *Alcanivorax borkumensis* (alkane-devouring bacterium) and *Marinobacter hydrocarbonoclasticus* (hydrocarbon-degrading sea bacterium). Some species, like those in the genus *Marinobacter*, have also been named according to the location they were found in. And here, again, there is tremendous variation. Hydrocarbon-degrading species have been isolated from seawater, freshwater, groundwater, sludge, silt, soil and even sand. They have also been isolated from all over the world, and in all climates, from the arid environment of the Middle East to the Antarctic – some have even been found in ice cores! You can be sure that if oil is present, or has been in the past, you will be able to find hydrocarbon-degrading bacteria.

More often than not, researchers have found whole bacterial communities capable of degrading the various constituents of crude oil in a particular location, rather than just individual species. Because crude oil is comprised of many different hydrocarbons, different bacterial species with various metabolic capabilities are involved in the degradation of the different compounds available. Some of these species are specialists, with a preference for only one or two of the hydrocarbons available, while others are generalists and capable of utilizing many of the compounds on offer. In addition, some species are consistently found in low numbers, regardless of the availability of the hydrocarbon source, whereas others thrive and dominate when oil is abundant. These communities effectively share the task of degrading the various compounds on offer.



Coloured transmission electron micrograph (TEM) of an oil-degrading bacterium (pink) collected from a deep-sea oil plume in the Gulf of Mexico after the *Deepwater Horizon* oil spill. This is a previously unknown species of bacteria that is closely related to *Oceanospirillales* bacteria. This is one of the species of marine bacteria that are breaking down the oil from the spill, around one kilometre below the ocean's surface, at a much faster rate than expected. *Hazen Group, Lawrence Berkeley National Laboratory / Science Photo Library*

CLEAN-UP STRATEGIES INVOLVING BACTERIAL DEGRADATION

The exploitation of bacterial degradation of hydrocarbons is now a growing industry around the world. There is a huge number of companies offering to clean up polluted environments by using bacteria in a number of different remediation scenarios. It is now even possible to purchase freeze-dried, hydrocarbon-degrading bacteria in powder form which can be applied to the polluted site! The effectiveness of such a strategy is somewhat dubious, however.

The process that involves the use the pollutant-degrading capabilities of living organisms, most often bacteria, fungi and plants, to clean up contaminated sites has been named bioremediation. Bioremediation comes in a number of forms, ranging from the monitoring of the natural degradation taking place, to boosting the activity of indigenous degrading organisms by the addition of nutrients (biostimulation), to the addition of living organisms which are able to degrade the pollutant at the site (bioaugmentation).

Biosurfactants (natural detergents) which break up crude oil, making it easier to degrade, are also often used. Remediation can take place *in situ* (at the contaminated site) or *ex situ* (the polluted soil or water can be removed and remediated elsewhere). Degrading organisms have even been immobilized onto a surface, a method which has been shown to enhance their survival. The bacteria used can be indigenous (derived from the site) or exogenous (not native to the site). Some species have been genetically engineered to make them particularly effective at pollutant degradation.

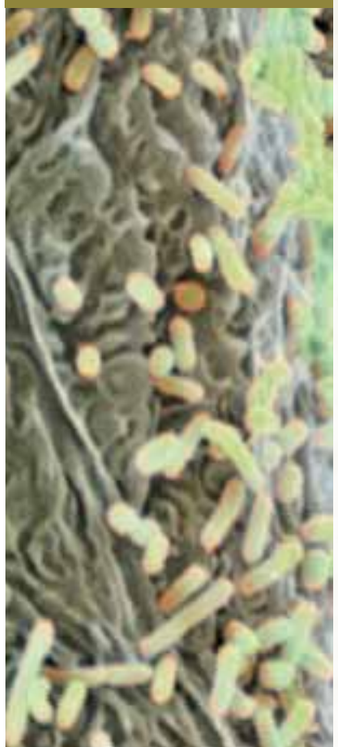
Unfortunately, bioremediation is not always effective. This can be due to the pollutant simply not being accessible to the degrading bacteria or because the organisms are not capable of surviving the environmental conditions. Often, micro-organisms cultured under laboratory conditions are applied to a site which is just not suited to their survival. The most successful bioaugmentation strategies have involved the use of indigenous organisms as they are best adapted to the site.

Nature is well equipped to deal with minor spills due to the huge diversity of organisms capable of metabolizing hydrocarbons and the various strategies which they employ. Scientists have been studying bacterial degradation of hydrocarbons over the years, and their research has given us a valuable insight into the processes and organisms involved. Around the world, vital research is currently being carried out which will allow us to harness the amazing abilities of bacteria more efficiently to clean up polluted sites in future.

LENA CIRIC is a Postdoctoral Research Fellow in the Department of Microbial Diseases, UCL Eastman Dental Institute, 256 Gray's Inn Road, London WC1X 8LD (tel. 020 7915 1008; fax 020 7915 1127; email l.ciric@eastman.ucl.ac.uk)

Coloured scanning electron micrograph of *Escherichia coli* bacteria in the gut. *Steve Gschmeissner / Science Photo Library*

There are more 'non-human' cells in the human body than 'human' ones, and the majority of these live in our gut. For most of the time, they live in relative harmony with each other and with our bodies, but disturb the balance and the results can be very unpleasant.



THE GASTROINTESTINAL TRACT contains one of the most complex and diverse ecosystems found on the planet. The micro-organisms (microbiota: mainly bacteria) inhabiting this harsh and varying environment have to cope with physical and chemical extremes, as well as the host's immune defences.

Bacteria inhabiting the gut must enter via the mouth. They traverse the acidic stomach, and then travel through the small intestine where exposure to the powerful detergent actions of bile and destructive enzymes are maximal and flow rate is high. Oxygen becomes increasingly limiting, and by the time the large intestine is reached the conditions are extremely anaerobic and many toxic metabolites are produced there. However, the microbiota should not be considered a constantly flowing stream of micro-organisms that will be ultimately all eliminated in faeces: many are adherent, and even those free in the lumen have a division rate that exceeds the flow rate, so reaching a steady state that prevents their wash through.

TYPES OF BACTERIA FOUND IN THE DIFFERENT ZONES OF THE GUT

Most organisms entering the stomach acid are quickly killed. Only acid-resistant species and spore-formers readily survive. However, those shielded by food are not necessarily exposed to the acid and can survive if transit time is short. Malnutrition, which often results in low stomach acid, and medications to reduce acid production (proton-pump inhibitors and H_2 antagonists) can severely reduce the protection that the gut acid affords. However, some species, such as the well-known *Helicobacter pylori*, are commonly present as permanent inhabitants of the stomach. It is not unusual to find 50% of adults in the developed world colonized by *H. pylori* with up to 100% in some developing countries. This association is relatively harmless in many individuals who only on occasion suffer dyspepsia of varying severity. *Helicobacter* bacteria survive the acidic environment by burrowing into the mucous lining of the stomach and producing an alkaline shield by converting urea to ammonia using their own urease enzyme. In its role as a pathogen, *H. pylori* is the most common cause of stomach ulcers and also causes stomach cancer in a tiny minority of cases.

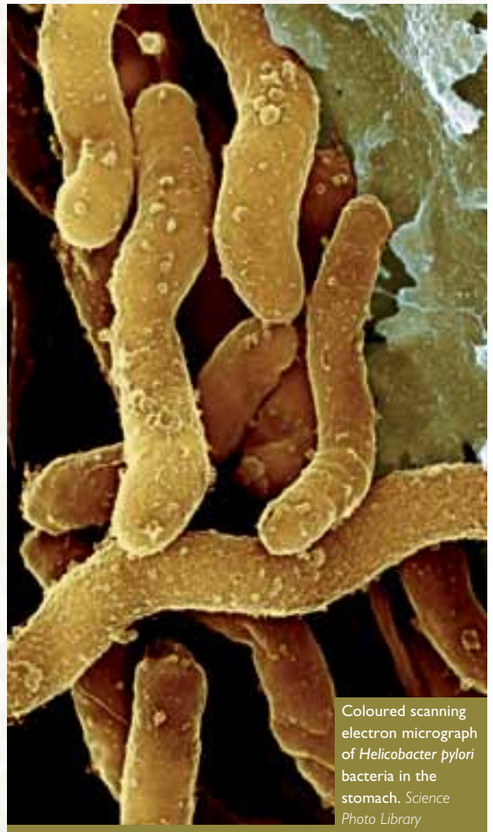
In the small intestine (jejunum, duodenum and ileum), the ability to adhere is crucial. This is to prevent 'wash-out' by peristalsis and the high flow rate of the contents. Here, the facultatively anaerobic enterobacterial species, such as *Escherichia coli* and other Gram-negative rods, begin to thrive. As the small intestine is the principle site for absorption of water, the flow rate markedly falls and oxygen utilization by the facultatively anaerobic species results in an increasingly anaerobic environment. In the large intestine (colon), the types of different bacteria as well as the total numbers increase and strictly anaerobic species, such as the Gram-negative *Bacteroides* and Gram-positive *Bifidobacterium* and *Eubacterium* species, predominate.

IAN POXTON

NUMBERS OF BACTERIA IN THE GUT

The major part of the human microbiome (the micro-organisms in and on the human body) is found in the gut, with smaller numbers in the oral cavity, the urogenital tract and the skin. Most estimates of the number of bacteria present in the gut are based on faecal counts. However, this represents the luminal (non-adherent) microbiota of the distal colon, and it should be recognized that there are distinct adherent populations associated with the mucus lining the gut. Also, the populations present in the upper parts of the gut will probably not have survived and will be absent from faeces. Collection of samples representing these non-faecal populations is ethically and practically difficult, and can usually only be done during surgery of the bowel (when the populations may not be normal because of disease or pre-surgical antibiotic administration). Counts in the region of 10^{11}–10^{12} bacteria per gram of gut contents or 10^{13}–10^{14} in total are usually quoted. This can be compared to the total number of eukaryotic cells making up the human body, which is estimated to be around 10^{13}. Therefore, the human microbiome outnumbers 'human' cells in our body by up to 10-fold.

E. coli is often thought of as the most common, archetypal gut inhabitant; however, it only reaches levels of 10^7 cells per gram and is therefore a minor component of the gut microbiota. The strict anaerobes, such as *Bacteroides* species, reach levels of more than 10^{10}



Coloured scanning electron micrograph of *Helicobacter pylori* bacteria in the stomach. *Science Photo Library*

Bacterial communities in the gut

and the consequences of upsetting them

cells per gram, thus outnumbering *E. coli* by 1,000-fold.

Early estimates of the number of different bacterial species found in the gut, based largely on those that could be cultured, were in the order of 400 species. Of these, however, only a few tens of species constitute the majority of the total microbiota. More recently, by means of molecular methods which detect specific signatures of 16S ribosomal RNA genes, it can be estimated that there are at least twice this number of species, with the majority unculturable – at least at present.

The most common phyla detected by molecular methods are *Bacteroidetes* (*Bacteroides* species) and *Firmicutes* (mainly *Clostridium* species). Unsurprisingly, species belonging to the phylum *Proteobacteria* (*E. coli* and other enterobacteria) are uncommonly detected, no doubt because of there relatively low numerical abundance (0.1% compared to *Bacteroides* spp.).

FUNCTION OF THE GASTROINTESTINAL MICROBIOTA

Although seemingly an unaesthetical inconvenience at times – the result of the digestion of the food we have eaten – the gut microbiota has many beneficial roles:

Nutrition. Certain bacteria possess enzymes that we cannot make ourselves but which are necessary to breakdown complex carbohydrates to absorbable sugars. Recently, links have been made with certain bacterial populations and obesity.

Colonization resistance. The normal commensal bacteria prevent colonization by pathogenic species by occupying niches that pathogens might exploit (read about *Clostridium difficile* infections below).

Maturation of the gut epithelial layer. In germ-free animals* the normal architecture of the cells lining the gut does not occur, and it is thought that various bacterial products promote the normal development of these cells.

Development of the immune system. Again in germ-free animals both the innate and acquired immune systems do not develop as normal, and the production of immunoactive bacterial products induce immune tissue differentiation and maturation.

Various interactions occur between members of the gut microbiota and these can be beneficial or harmful. Bacterial populations that grow as adherent biofilms allow nutrient exchange between neighbouring cells. Also, antibacterial products, including volatile fatty acids and bacteriocins, are produced which control the neighbouring species. However, close associations also permit horizontal transfer of genes (such as those encoding antibiotic resistance) between different species.

"Antibiotics disturb the colonization resistance offered by the normal microbiota."

*Germ-free animals are produced by delivering them by Caesarean section into a sterile environment and maintaining them there with sterile food, water and air. In the uterus the foetus is bacteriologically sterile.

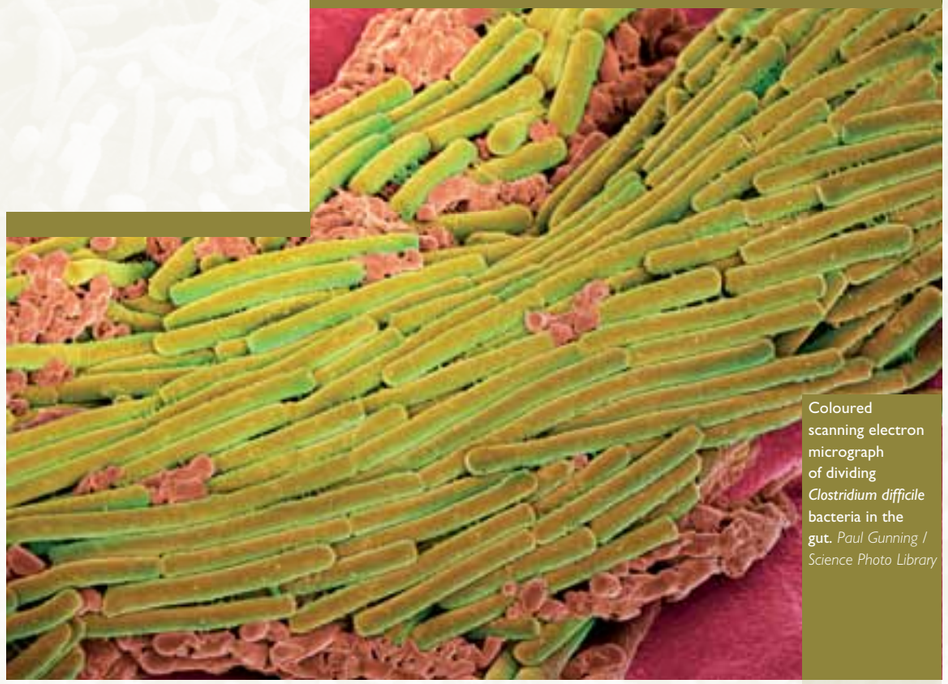
GI DISEASE: VOMITING AND DIARRHOEA

Many pathogens of the GI tract possess adhesion mechanisms. These allow the bacteria to stick to the gut wall and prevent their washout by the relatively high flow rate in the upper part of the gut, and where competition from commensal bacteria is minimal. Once stuck to the gut wall, exotoxins are commonly produced. These affect the cells lining the gut and produce an imbalance of absorption and secretion of fluids, resulting in diarrhoea. This is sometimes watery, as in cholera when the cells are deregulated but not killed. However, sometimes blood is present when the cells lining the gut are severely damaged, such as during *Shigella* infections (bacterial dysentery) and enterohaemorrhagic *E. coli* infections (caused by *E. coli* O157). Vomiting tends to be the result of indirect action of the toxins on the nerves in the gut sending messages to the vomiting centre of the brain.

ANTIBIOTIC-ASSOCIATED DISEASE

Antibiotics taken orally are designed to be absorbed from the gut into the bloodstream and deliver their antibacterial action at the required site. However, it is not uncommon for the gut microbiota to be disturbed following antibiotic administration, resulting in diarrhoea. This is usually transient, and gut functions appear to return to normal quickly. However, recent studies have examined the various components of the gut microbiota in detail and it has been found that it can take several months for some genera to repopulate the gut and return to normal levels.

One of the more severe consequences of disturbance of the microbiota by antibiotics is infection caused by *C. difficile*.



Coloured scanning electron micrograph of dividing *Clostridium difficile* bacteria in the gut. *Paul Gunning / Science Photo Library*

C. DIFFICILE INFECTIONS

In the early part of this century, the general public were made acutely aware of one of the serious consequences of antibiotics disturbing the gut microbiota. Although antibiotic-associated colitis had been known to be caused by *C. difficile* since the late 1970s, and had been increasing steadily, it remained generally unknown except by the medical profession and scientists working in the field. However, in 2002 and 2003, outbreaks in Canada (around Montreal) and the UK (initially at Stoke Mandeville hospital) heralded the arrival of a new, hypervirulent strain known as PCR ribotype 027. '*C. diff*.' soon became the new superbug, being widely reported in the news media and in government circles. The previous no. 1, infamous superbug, MRSA, has been overtaken by *C. difficile* both in real numbers of cases and in the popularity stakes!

Although relatively common as a member of the gut microbiota of newborns, where it does no harm, it is in adults, particularly elderly, hospital inpatients receiving antibiotics for all sorts of reasons, who are susceptible to *C. difficile* infections (CDI). Antibiotics disturb the colonization resistance offered by the normal microbiota. Following the ingestion of *C. difficile* spores, which are triggered to germinate in the small intestine, the bacteria then multiply in the colon and produce two powerful toxins. These kill the cells lining the gut as well as causing local inflammation. The resultant symptoms of CDI range from mild, self-limiting diarrhoea to severe colitis with the possibility of life-threatening fulminant colitis and toxic megacolon. However, some patients who are colonized remain well – presumably protected by their immune system.

An inflamed and nodular colon in a case of pseudo-membranous colitis. This is due to a toxin released by an over-abundance of *C. difficile* bacteria. *David Martin, MD / Science Photo Library*

Curing CDI is usually accomplished by treatment with the antibiotics vancomycin or metronidazole. However, relapse is common, and this is almost certainly because the gut microbiota remains disturbed, probably exacerbated by the antibiotic treatment. New treatments with narrower spectrum antibiotics, such as fidaxomicin, are less damaging to the gut microbiota and fewer relapses are encountered. The most successful treatment, but certainly not the most aesthetic, involves restoring the microbiota with normal faeces (faecal transplant). Many centres are attempting to identify the crucial species in normal faeces with the hope that a probiotic approach might be used therapeutically. Commercially available probiotics do not seem to have any major uses in the prevention or treatment of CDI at present.

However, the number of CDI cases is decreasing in the UK and some places in Europe, albeit from an unacceptably high level. This reduction is due to a combination of improved cleaning, strict infection control and more prudent use of antibiotics – especially those recognized as being good at precipitating the disease. However, in some parts of the world, notably in North America, CDI still appears to be increasing.

SOME FINAL WORDS

The gut microbiota is complex, and throughout normal life it maintains homeostasis, being remarkably robust to challenges from different diets and lifestyles. However, it does suffer when infection occurs in the gut (caused by pathogenic strains of bacteria, viruses or eukaryotic parasites) or when major components of the gut microbiota are affected by antibiotics.

Many of the apparently harmless (commensal) species that inhabit the gut are recognized as important opportunist pathogens, however. Their movement to other sites through injury or a change in gut physiology can result in serious extraintestinal infections, such as peritonitis (when faeces enters the peritoneal cavity) or urinary tract infection (when specialized types of *E. coli* enter the urinary tract by the ascending route). Faecal contamination of a wound, especially if there has been severe trauma/restricted blood flow can result in an anaerobic wound infection, often a 'mixed' infection, with gangrene being one of the most severe outcomes.

IAN R. POXTON is Professor of Microbial Infection and Immunity at the Centre for Infectious Diseases, University of Edinburgh College of Medicine and Veterinary Medicine, The Chancellor's Building, 49 Little France Crescent, Edinburgh EH16 4SB (tel. 0131 242 9122; email i.r.poxton@ed.ac.uk)

Cross-curricular drama has been used for many years to engage the public with scientific issues and to support meaningful science learning in schools, allowing participants to reflect on the nature of science. Two major strategies have developed: the first uses real-life social simulations to provide a context for the presentation and application of scientific ideas, as well as discussion about attitudes, ethics and values where these are relevant; the second uses mime and role-play to model abstract scientific concepts.

Communicating microbiology through a drama-based strategy

IN 1997, an evaluation of Theatre Debate, commissioned by The Wellcome Trust and carried out by Y. Touring – which addressed controversial science topics using dramatic performance and debate concluded that:

'*Arts projects such as these were seen to be very successful in delivering science education. The drama is a way into a lot of areas and enhances the subject especially for those who are alienated or threatened by science.* The Gift *(one of the science topics) successfully contributes to science teaching – its strength is in personalizing science rather than delivering biological information.*'

The sciences, including microbiology, are often perceived as challenging subjects to communicate. The Society is constantly looking at new ways to encourage a greater public understanding of microbiology and finding alternative approaches to engage with new audiences – including those not necessarily interested in microbiology.

In September 2009, the Society agreed to sponsor Cheltenham Science Festival and put on two activities for the general public. This was an ideal opportunity for us to try something new, and it was at this point that an idea which had been bubbling around in the back of Dariel's mind finally hatched, and the drama *Stopping the Spread of Superbugs* was born. However, that was just the beginning of a very long, sometimes frustrating, but ultimately rewarding experience to give this project wings so it could fly. Bringing together experts from the arts and science community was always going to be challenging, drawing together different perspectives and backgrounds. Ultimately, the interaction and vision of the group made the drama a success, as the play works both as a piece of theatre while still managing to highlight some of the key scientific and ethical issues faced by infection control professionals and patients alike.

Stopping the Spread of Superbugs was brought to life on stage at Cheltenham Science Festival through the dialogue between two hospital cleaners. The story unfolds to reveal the fears and concerns experienced by one of the cleaners after her mother is re-admitted to hospital with an infection following routine surgery. A panel of 'infection control professionals' was on-hand to answer any questions that arose during the play. The audience was invited to put themselves in the shoes of the hospital decision-makers to answer some of the questions they face on a daily basis:

- Should all hospital patients be pre-screened for superbugs on admission?
- Should antibiotics be used as a precautionary measure?
- How do infections arise at all if strict protocols are followed?

The drama, which featured as one of the top 5 things to see at Cheltenham Science Festival, was a great success and we received positive feedback from the audience.

At the end there was a feeling of jubilation followed by '*What now!*' The play had been captured on film; we had the script and also a recorded Q and A session. The SGM had a fantastic resource – how could we maximize its potential?

We have gone down two separate avenues. The first is to have a Video Portal designed by the film company so that the recording of the play is be streamed via both our education website **www.microbiologyonline.org.uk** and the main SGM website **www.sgm.ac.uk**. This is accompanied by the Q and A session which addresses various issues around hospital-acquired infections. The script will also be made available to SGM members involved in outreach and SGM School Corporate members. This will allow students to take on the role of the key stakeholders in the case scenario, for example experts on the panel and also the two cleaners. The rest of the student group will make up the audience. Role-playing will allow the students

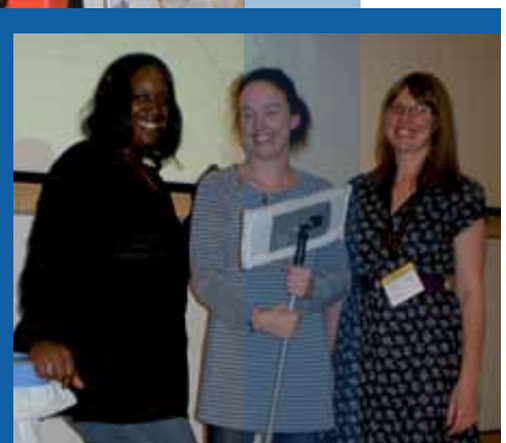
to prepare some of the information they plan to present, but will also force them to answer questions or discuss topics that they may not have anticipated.

The second approach was to reproduce the play at other suitable venues. Our first opportunity came hot on the heels of Cheltenham and we were able to stage the show at our Autumn Conference at the University of Nottingham. Council member, Kim Hardie, from Nottingham University very kindly recruited local experts for the panel. For continuity, Anthony Hilton, who had appeared at the original event, agreed once again to be the facilitator. We were also lucky enough to engage the same actors and theatre company.

Vicki Symington, our new Education and Outreach Administrator, gives her view on the second outing of *Stopping the Spread of Superbugs*.

"It really did match up fantastically with the A2 Edexcel scheme of work and I feel that the performance taught the topic and answered questions very well. Leaving little for me to do except to revise the topic later this year for revision. The two ladies who played the roles of the cleaners were great and it was fantastic to have real experts to field the questions."

Sarah Pike, Science Teacher, Lincoln Christ's Hospital School



Above. The panel of experts in Nottingham: Kim Hardie, Adam Roberts, Jacqueline Randle, Anthony Hilton (facilitator) and Roger Bayston. *Right*. The two actresses Marcia Mantack (left) and Kate Adams (centre) with their director Ellen Dowell. *I. Atherton*

STOPPING THE SPREAD OF SUPERBUGS IN NOTTINGHAM!

Just before I started work at SGM I was volunteering at Cheltenham Science Festival (June 2010). Cheltenham, as one of the UK's largest science festivals, exhibits microbiologists alongside intellectual property and technology experts, mathematicians alongside meteorologists and pharmacologists (amongst many others), and it showcases talks from top celebrity scientists to jobbing postdoctoral scientists and interested individuals. Cheltenham delivers science in new ways to the engaged and unengaged public. This year something novel caught my eye – a play… about superbugs? I must admit they had me there. I wanted to go, then lo and behold I see the organizer and sponsor of the event, my soon to be employer!

As a festival volunteer I ended up working the audiovisual (AV) set-up for this event. I was anxious from a technical perspective – as a volunteer AV assistant, that's normal – and anxious not to mess-up in front of SGM staff, but I was also excited to see what sort of events the SGM would deliver as inevitably these are the events I would be, and am now, involved with in my new job.

The play began and I was immediately drawn into the dialogue and the emotion of the situation. The acting was fantastic and the audience was engaged. At the end of Act One the play paused for Q&A to the scientists on stage. I was amazed at the audience's reaction, and from the questions posed to the scientists, it was clear that there were general misunderstandings of the basic science behind antibiotic resistance and so-called 'superbugs', but the public was interested in what the scientists had to say and were engaging with them. The event continued and by the end it genuinely felt like it had managed to inform and deliver the information that the audience yearned for. The audience seemed impressed by the new method of science delivery – SGM were delighted with the response.

As a first outing for '*Superbugs*' the event went very well; however, on reflection we decided that the event could be improved by altering the running order slightly (*note*: I say 'we', as of the 21 June I came on-board as a member of the External Relations Department at SGM). One of my first jobs was to help design and advertise our public event at the SGM Autumn Conference in Nottingham; this was to be the second outing for the play. With the help of my colleagues I put the flier together and we distributed it to schools, colleges, universities, leisure centres, libraries, healthcare facilities, café scientifiques, theatres, cinemas and anywhere else we could think of in Nottingham and the surrounding areas. We aimed to ensure a web presence for the event on *Facebook*, *Twitter* and any Nottingham events pages we could find! All we could do was wait and see who turned up on the day!

A section of the Nottingham audience. *K. Rowlett*

As I was not running the event myself, I was to be on-hand to do the odd jobs that come up when putting an event on – mostly checking the equipment and making sure speakers and actors were where they were supposed to be in the lead up to the event! When 6.30 pm arrived on 8 September we were ready to go. The doors opened and more than 130 people filed into the lecture theatre; among the delegates from the conference were members of the public, university students, local healthcare workers and several school groups. Fantastic, we were thrilled at the turn-out! This time we had a different scientific panel who were able to bring their expertise to the melting pot. They all did a fantastic job answering questions from the relatively simple *what does MRSA stand for?* to *how long does MRSA persist on hospital reading materials?*, and down to the 'nitty-gritty' of virulence factors!

As the audience was a mix of abilities, I think that some were anxious to ask questions for fear of embarrassment; however, those brave enough to let their voices be heard could get the answers to their questions.

Once again, the response from the audience was positive and we have already had a request to repeat *Stopping The Spread of Superbugs* at Waterford Institute of Technology, Ireland.

SGM would like to take this opportunity to thank the microbiology experts **TONY BERENDT**, Executive Medical Director, Director of Infection Prevention and Control and Consultant Physician, Bone Infection Unit, Nuffield Orthopaedic Centre NHS Trust; **ANTHONY HILTON**, Reader in Microbiology, Aston University and **MARTIN KIERAN**, President of the Infection Prevention Society who helped to develop the case scenario, sat as experts on the panel and also came back to Cheltenham to film an additional section that hopefully answers frequently asked questions regarding hospital-acquired infections. SGM would also like to thank the director of Qualiatheatre, **ELLEN DOWELL**, her scriptwriter and actors who played the two cleaners.

We would also like to thank the panel of experts that took part in the Nottingham production. **KIM HARDIE**, Associate Professor, Nottingham University; **ROGER BAYSTON**, Associate Professor & Reader in Surgical Infection, Faculty of Medicine & Health Sciences, Nottingham University; **JACQUELINE RANDLE**, Associate Professor, Nottingham University and **ADAM P. ROBERTS**, Lecturer in Molecular Microbiology, UCL Eastman Dental Institute.

DARIEL BURDASS is Head of Education, Professional Affairs and Outreach at SGM (email d.burdass@sgm.ac.uk)

VICKI SYMINGTON is Education and Outreach Administrator at SGM (email v.symington@sgm.ac.uk)

REFERENCES

www.ytouring.org.uk

Evaluation Associates (1997). *Cracked: A Study of Impact.*

New infectious disease web resources

From the structure of bacteria, viruses, fungi and protozoa to the development of medicines to treat infectious disease, all aspects of this topic are covered in a set of new resources from the Association of the British Pharmaceutical Industry on their website for schools, **www.abpischools.org.uk**

General information on pathogens, how they grow and cause disease is the subject of *Pathogens* (**www.abpischools.org.uk/page/modules/infectiousdiseases_pathogens/index.cfm**); Preventing the spread of infectious disease is covered from an historical angle in the *Timeline* (**www.abpischools.org.uk/page/modules/infectiousdiseases_timeline/index.cfm**); modern vaccinations in *Immunity* (**www.abpischools.org.uk/page/modules/infectiousdiseases_immunity/index.cfm**); and treatment of bacterial infection through use of antibiotics and the science behind antibiotic resistance are explored in *Medicines* (**www.abpischools.org.uk/page/modules/infectiousdiseases_medicines/index.cfm**). *Diseases* (**www.abpischools.org.uk/page/modules/diseases/diseases1.cfm**) covers the common infectious diseases listed in GCSE specifications.

Reviews

Empire of the Microbes:

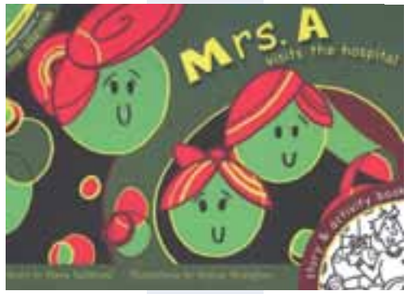
Science Short Course

Authors C. Cockell & A. Brown
Publisher Open University (2010)
Details Part of OU course | pp. 239 | ISBN 978-1-84873-008-3
Reviewer Alan Cann, University of Leicester

Empire of the Microbes is an excellent introductory-level, general microbiology text, originally written to accompany the Open University course of the same name. The usual OU production values with full colour illustrations make this a visually attractive offering, something which is increasingly important in terms of student acceptance. In addition to the expected content, there is good coverage of the environmental aspects of microbiology, and some consideration of industrial microbiology as well. The self-assessment questions and activities in the text are a particularly useful feature. The accompanying DVD-ROM includes a few videos and a version of the OU Digital Microscope, although the Flash-based interface did not work with the current version of the Flash player on Macintosh OS X.

This book has a definite niche and would be very useful in schools where teachers have little background knowledge of microbiology, but its success will depend critically on price as the textbook market slowly contracts in the face of free online resources of ever-increasing quality.

This book is only available as part of the OU course: for further details, see **www.open.ac.uk/yass**



Mrs. A Visits the Hospital

Author S. Sellwood
Publisher NHS (2010)
Details £3.99 | pp. 28 | ISBN 978-0-95654-751-4
Reviewer Vicki Symington, SGM

In a bid to keep on top of in-house infections, the Royal Berkshire Hospital has produced this children's book to encourage hand washing from an early age by visitors to the hospital. The book has clear intentions, and the concept is really fantastic, though it occasionally falls short of the mark.

The story introduces Mrs. A, her daughter Staphylococcus (Staphy for short) and her son Aureus who live happily in the nose of Maureen. The book follows Aureus as he leaves the safety of Maureen's nose and travels on the hand of a boy called Calum onto different surfaces around the hospital, multiplying every time!

Full of quirky rhymes, activities and excellent illustrations, this book is very engaging and does get the hand washing concept across to the reader. However, it is very text heavy, some of the fonts used are difficult to read in places, and it is likely that the name *Mrs. A* will be lost on many readers both young and old. That said of course, it is nice to see hygiene messages being delivered in this way.

Coming soon: *Cholera: Death by Diarrhoea*

In a year where floods have hit Pakistan and cholera is rife, it is timely that the SGM release their latest factfile *Cholera: Death by Diarrhoea*. The factfile charts the history of the disease and investigates the cause, symptoms, diagnosis, treatment, and prevention of the disease as well as vaccine development and community education strategies. The resource is targeted at post-16 students and single copies will be available for free. Multiple copies can be supplied to SGM Corporate School members on request.

Inspiring Tomorrow's Scientists

Alimentary Pharmabiotic Centre

The Alimentary Pharmabiotic Centre (APC; http://apc.ucc.ie) is a University College Cork/ Teagasc Research Centre funded by Science Foundation Ireland and industry, focusing on gastrointestinal health and development of therapies for debilitating disorders such as Crohn's disease, colitis, irritable bowel syndrome (IBS) and food poisoning. One of the goals of the APC is to stimulate an interest in, and appreciation of, science in the general public, especially among primary and secondary level students and their teachers.

The APC is committed to keeping the public abreast of new therapeutic developments, ongoing clinical trials and exciting new research findings through its *Bringing Science to Society* programme. The APC has two websites (one for the public and one designed for children) which are updated regularly. Several times a year public and patient events take place with formal presentations followed by extensive question and answer sessions where the audience are actively encouraged to engage in discussion. Many of these events take place annually, e.g. the World Digestive Health Day.

MicrobeMagic@School is the APC's primary school programme. Primary school teachers are supported through APC scientists visiting schools, providing interactive talks on topics such as the digestive system, the immune system, the heart and circulatory system and the five senses. Hands-on experiments are included and teachers are provided with packs which include background material and follow-up activities. To date we have visited more than 33,000 Irish primary school pupils. The APC's Microbe Magic website **http://microbemagic.ucc.ie/** is a wonderful resource for students, parents and for teachers. There are games to play, quizzes, experiments to do and your questions can be answered online by an APC scientist. Characters such as GI Jake, a bifidobacterium and Luke O'Cyte, a white blood cell, captivate children, and educational multimedia tools, including the computer games, *Gut Reaction* and *Gut Buster*, teach young people about the importance of bacteria in the gut. APC also hosts interactive stands at exhibitions, and has also provided workshops at Cork's *Lifetime Lab* and at the Royal Dublin Society through their Science Live Bursary scheme.

Budding Biologists is APC's Secondary School Programme. It provides students with the opportunity to conduct 'hands-on' experiments in university laboratories and hosts an annual Transition Year Experience programme, which encourages students aged ~16 years, to study science subjects for the Leaving Certificate and subsequently at third level. The programme offers students a unique insight into the multidisciplinary nature of research at UCC, providing them with an action-packed programme of laboratory-based and other activities, including workshops on careers, presentation skills, report writing, demonstrations of UCC's state-of-the-art equipment and tours of the facilities and campus.

Science Raps Challenge is a competition organized by the APC which aims to encourage young people to express their thoughts about science and technology through rap music. The inaugural competition in 2009, in which the APC invited science rapper Jonathan Chase to challenge kids to submit raps on the theme of *Celebrating Creativity and Innovation*, had some great entries, and some of these can be viewed on *YouTube*'s pharmabiotic channel. '*The school vibrated with science during the competition. Students and staff who never associated fun and music with science enjoyed performances by a mixture of 2nd and 5th year students. The students themselves enthused about the subject as they bonded while trying to put science facts into rap. Science teachers are considering putting all their classes into rap, such was the positive response!*' said Rosemary Ferriter, a teacher from St Vincent's Secondary School in Cork. The theme for this year's competition is 'Our place in space' – full details are available on the APC website.

The APC is also a partner in *Debating Science Issues*, a national inter-school debating competition, funded by the Wellcome Trust, with other research centres in Ireland. The ethical implications of current biomedical issues from GM food to stem cells, from vaccination to nanotechnology are all debated throughout Ireland in a competition.

CATHERINE BUCKLEY is the Education and Outreach Manager, APC, BioSciences Institute, University College Cork, Ireland (tel. 353 21 4903362; email c.buckley@ucc.ie)

SGM CALENDAR

SGM is launching a calendar for 2011 which will be available to school members and parliamentarians. The calendar, which will feature beautiful microbiological images alongside notable dates in the microbiology calendar, will be distributed by the end of December 2010.

UPDATES AND ADVICE FOR EARLY CAREER MICROBIOLOGISTS

Gradline aims to inform and entertain members in the early stages of their career in microbiology. This issue introduces a new member of the Gradline team – **KAREN MCGREGOR**. Karen has worked as a researcher and educator in a number of UK universities and is committed to supporting the development of microbiology and microbiologists. If you have any news or stories, or would like to see any topics featured, contact Karen McGregor (k.mcgregor@sgm.ac.uk).

Looking after your career

KAREN MCGREGOR REPORTS ON THE LATEST NEWS FROM VITAE.

For anyone who doesn't know – and if you don't I recommend you look at their website (**www.vitae.ac.uk**) – Vitae is a national organization championing the professional and career development of researchers. The website offers a range of information, advice and services and includes sections for postgraduate researchers and research staff at all levels of their career.

In September 2010, Vitae held its third annual researcher development conference (presentations and workshop material from the conference are now available to view at the Vitae website). Of interest to those who are currently studying, or thinking of studying, for a doctoral degree are two major additions to the *What do researchers do?* series of publications. The first, *Doctoral graduate destinations and impact three years on*, presents the results of a comprehensive survey of >2,500 participants on their doctoral experiences, how they found and secured employment, their employment destinations, and what knowledge and skills from their doctorate they use in their employment. The second, *Career profiles of doctoral entrepreneurs*, is a collection of 30 career stories from doctorally qualified individuals who went on to set up their own business or enterprise.

It is not enough to have all these materials and resources freely available – researchers have to take the initiative to use them. A recent survey of researchers (by the *Careers in Research Online Survey*) found that only 18% of researchers in biological sciences were spending >10 days per year (as recommended in *SET for Success*) on their continuing professional development. At the conference, Vitae launched the Researcher Development Framework and an associated downloadable tool aimed at making it easy for researchers to engage in and record their development. Dr Emma Gillaspy from Vitae describes these exciting new resources.

VITAE RESEARCHER DEVELOPMENT FRAMEWORK (RDF)

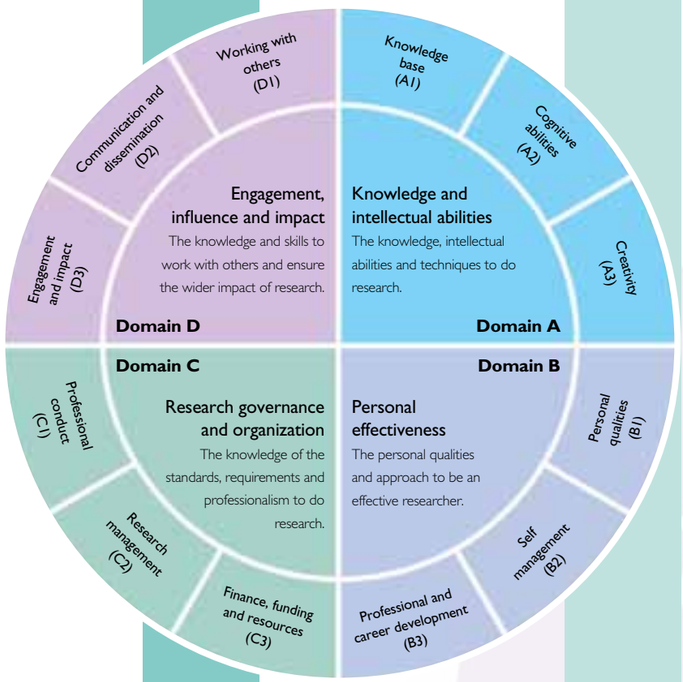
ARE YOU FULLY ENGAGED IN YOUR PERSONAL AND PROFESSIONAL DEVELOPMENT PLANNING?

Everyone has been guilty of letting professional development (and keeping records of that development) fall by the wayside. That is until they have to apply for a new research position or decide to change careers altogether. Being more aware of your skills and having a plan for future development will help you to make the right choices at the right times in your career.

Vitae have recently launched the RDF which will help you do just that. The RDF describes the knowledge, behaviours and attitudes of researchers at all stages of development from first-year postgraduate researchers through to high-profile research leaders.

WHAT DOES THE RDF LOOK LIKE?

The RDF is structured in four domains (A–D), encompassing what researchers need to know to do research and how to be effective in their approach to research when working with others and in contributing to the wider environment. The domains are further divided into sub-domains (e.g. A1, A2 and A3), each with descriptors and phases (1–5; representing a progressively higher level of skills in that area) which seek to capture the knowledge, behaviours and attitudes of a typically 'good' researcher at different stages of development.



HOW TO USE THE RDF

You might want to use the RDF to:

- prepare for one-to-one reviews with your supervisor, research manager or principal investigator where you will be discussing your professional or career development;
- identify strengths and areas to focus on;
- prioritize the most appropriate formal and informal development opportunities provided by your institution and/or external bodies;
- consider skills and experiences that will enhance your prospects of success in particular career areas.

Vitae have also launched a personal CPD tool to help you map yourself against the RDF. The self-reflection tool is available to download now from **www.vitae.ac.uk/rdftool**. It uses Microsoft Excel as a platform and allows you to:

- select which areas of the RDF you are interested in;
- record where you are currently and what your next target for development is;
- record evidence of your current skills and experience;
- complete an action plan to reach your target;
- save individual versions at different time points to track your own progress.

For more information or if you have any feedback or ideas for future developments using the RDF, visit **www.vitae.ac.uk/rdf** or contact **rdf@vitae.ac.uk**

EMMA GILLASPY is Vitae North West Hub Manager & Project lead RDF CPD tool development.

GRADLINE

USERS' COMMENTS

'It put career development back into the forefront of my mind as it can often slip back when you're engaged in what you're doing day-to-day. If you're prepared to put the effort in to think about the statements that are in [the RDF] *then I think it can really help.'*

Samantha Cartwright
PhD Student, Centre for Agri-Environment Research, University of Reading

'The RDF will encourage me to be more proactive about my career development as it provides me with a framework (list of milestones) that I can judge my current progress in relation to what I want to achieve with my career.'

Joe Viana
PhD student in the School of Management, University of Southampton

The RDF '*…identified areas for me that I needed to hone and really made me think about my career development. I've highlighted things now that I know I need to do.*'

Lynn McCallum
Senior Postdoctoral Research Fellow, School of Pharmacy, Queen's University Belfast

KAREN'S VIEW ON THE RDF

Generating a record of your current skills and experience, and completing an action plan to reach the next phase using the tool are great ways to take control of your personal and career development. Why not get someone else to read it (e.g. a colleague, your supervisor or principal investigator, or mentor) and give you feedback on how they perceive your current skills (you may be undershooting, or overshooting) and how realistic and achievable your targets are. Plus, telling someone else may also make it more likely that you will carry out the actions you describe.

The tool includes guidance notes on its use and a useful resources page with links to further information on personal development planning and careers. There is a lot of information in the RDF, but don't be overwhelmed; you don't have to complete it all (in one go), or attempt to leap straight from postgraduate researcher to winning the Nobel Prize! Start by making short term goals in priority areas that are most relevant to you now.

SUPPORTING RESEARCHER DEVELOPMENT

NATIONAL GRADSCHOOLS (FOR POSTGRADUATE RESEARCHERS)

The final Vitae GRADschool of 2010 is now fully booked, but further GRADschools will run in 2011. Attendance at GRADschools is free (subject to availability) for research council and Wellcome Trust funded students. For postgraduate researchers who are not funded by these sources, SGM offers grants for members towards the cost of attendance. Find out more at **www.sgm.ac.uk/grants/Gradschool.cfm**

UK RESEARCH STAFF ASSOCIATION

Vitae has supported the formation and development of the UKRSA. Their 2nd conference, *Empowering Researchers through Staff Associations*, was held on 4 November 2010 and the UKRSA website (**www.vitae.ac.uk/ukrsa**) will publish outcomes of this event. UKRSA also have a Facebook page where you can network with other research staff.

A JOB IN: MEDIA RELATIONS

PROFILE – LUCY GOODCHILD

- **Present occupation**
  Media Relations Manager, Global Reporting Initiative (GRI), The Netherlands
- **Previous employment**
  Press Officer, Imperial College London
  External Relations Administrator, SGM
- **Education**
  MSc: History of Science, Technology and Medicine, Imperial College London
  BSc: Microbiology and Genetics, University of Leeds

LUCY GOODCHILD HAS WORKED IN VARIOUS AREAS OF SCIENCE COMMUNICATION AND RECENTLY TOOK UP A MEDIA RELATIONS POSITION IN THE NETHERLANDS. KAREN MCGREGOR ASKED HER TO SHARE HER EXPERIENCE AND ANY USEFUL TIPS.

Q What led you to the field of science journalism and media relations?

A I see my career as a series of lucky breaks rather than stringent planning. During my final year of university my supervisor suggested I go into science communication. I had no idea what this was, but some further investigation suggested it combined my two favourite things; writing and science. I got in contact with a science magazine editor and asked if I could write an article, and they said yes. I continued gaining freelance writing jobs until the position at the Society for General Microbiology came up. I worked as assistant editor and writer on *Microbiology Today*. I also worked with scientists to produce press releases that I then promoted to journalists, and I produced podcasts and a blog to communicate science to the public. This part of the work stimulated an interest in media relations. I then moved to a position as a Press Officer at Imperial College London where I worked with a team of people to publicize medical research.

Q How did you get your current job?

A I was looking for something overseas and I enquired about a press office job with the publisher Elsevier. Applications for the job had already closed, but the head of press there sent me the details of the GRI position and I applied immediately. Four months and five interviews later, here I am!

Q Can you describe a typical day?

A So far, there hasn't been a typical day! Generally, I'll check the news in the morning to see if GRI has been mentioned anywhere, spend some time answering emails from reporters and bloggers, and get in touch with journalists to build and maintain relationships with them. I'm usually working on a number of big projects at any one time, so I'll have several meetings with people to discuss different projects – press launches, press releases, the annual report. I often have phone or Skype meetings with colleagues overseas too. I also work on responses to journalists' questions and drafting statements from GRI if there is something topical in the news. I generally try to spend time reading about sustainability reporting to make sure I'm well-informed on any new developments in this field.

Q What do you love about your current job?

A I love the fact that it's something new for me; I'm learning interesting things and I'm getting to know people in different sectors. This job has a strong link to science with climate change research and sustainable development high on the agenda, especially alternative and green energy, but I'm working closely with business journalists too.

Q What are the most important skills you need to successfully do your job?

A Media relations involves a lot of networking, so you need to be good at talking to people and remembering who they are. It's important to be a good writer and editor. A lot of the job is taking complex information and repackaging it for a lay audience so, regardless of the subject, you need to be able to understand the concepts and translate them into more simple forms. You also need to be interested in new media and keep up to date with the latest developments.

Q What advice can you offer people looking for a similar career?

A In this industry it's all about who you know – networking is definitely key to success, so get involved in as many events and networks as possible. Get your name out there, in print, on the internet or on the airwaves. Freelance, start a blog or help out as an intern somewhere. It's amazing how much being familiar on *Twitter* can help you in a job interview. It's really great fun, but it's hard work, so make sure you're doing something you love.

Microbiology Awareness Campaign

Microbes matter because they affect every aspect of our lives – in us, on us and around us. Making informed decisions about microbiological issues is a challenge for policy-makers and understanding the basic facts is essential.

LAURA UDAKIS

THE MICROBIOLOGY AWARENESS CAMPAIGN (MAC), run by the SGM aims to promote the understanding of microbiology and the important role of microbiologists to parliamentarians, opinion-formers and policy-makers. The SGM strives to meet this aim through a variety of activities designed to bring microbiologists, government officials and members of the civil service together.

PARLIAMENTARY EVENTS

The SGM regularly runs parliamentary events in England, Wales, Scotland and Ireland. In November 2010 the SGM is holding its event *Microbes and Climate Change* in the House of Lords, hosted by Lord Soulsby of Swaffham Prior. The 2-hour lunchtime event will cover the role of microbes as climate engineers, the impact of climate change on marine and soil microbiology and how climate change may affect the global burden of disease. At all such events, leading microbiologists are invited to give short presentations about developments in their field of research, highlighting the issues that need to be addressed by government, while delivering the key facts that must be understood. Peers and MPs are encouraged to participate in debate and discussion with scientists over an informal lunch and engage with exhibiting organizations about the work that they carry out.

PUBLICATIONS

The SGM distributes its own magazine *Microbiology Today* to peers, MPs, MSPs, AMs and MLAs, and members of the civil service as a source of information about current issues and research in microbiology. The SGM also places adverts in parliamentary publications such as *The House* and *Total Politics*. Adverts are often tied into science-themed issues and are designed to promote the SGM as a source of impartial, expert information for policy-makers.

BRIEFINGS

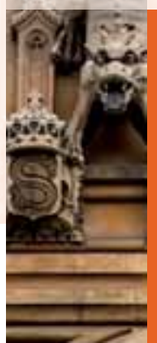
It is essential that government understands the basic facts behind pressing microbiological issues before policy decisions are taken. The SGM issues topical briefing papers to parliamentarians and other relevant decision-makers to provide need-to-know information rapidly. Recent briefings covered hospital superbugs and the H1N1 'swine flu' pandemic. These resources are prepared with the help of our members who are leading experts in their subjects.

CONSULTATIONS

The SGM works hard to formally respond to all relevant government consultations. SGM responses are compiled from evidence submitted by our members who are experts in the relevant field of microbiology. Recent consultations that we have had input into include the Food Standards Agency consultation on its *Food-borne Disease Strategy 2010–2015* and the Nuffield Council on Bioethics consultation on *New Approaches to Biofuels*. The responses to these consultations can be found on our website at **www.sgm.ac.uk/news/consultations.cfm**

WORKING WITH OTHER ORGANIZATIONS

The SGM is also active in more general science policy issues and works closely with other scientific organizations including the Society of Biology and the Campaign for Science and Engineering (CaSE) to ensure our voice is heard.



SGM members – we need your help!

The success of our Microbiology Awareness Campaign relies heavily on the support of you – our members, either to speak at events, fact-check briefing papers or to submit your views that will feed into consultation responses. Please complete and return to us the Experts form on the back cover of the magazine to help us carry out these important activities.

PUBLIC AFFAIRS DIARY 2010

The changeover of the government has kept the staff in the SGM Public Affairs office busy over the last few months. Here are a few of the things we've been involved in.

SCIENCE AND THE NATIONAL ASSEMBLY

In May, SGM went along to the *Science and the Assembly* event in Cardiff. The annual event, organized by the Royal Society of Chemistry, brought together the Welsh Assembly Government and Assembly Members with the scientific community to discuss topical science issues. Our exhibition stand was well-received with many delegates picking up briefing papers and copies of *Microbiology Today*, as well as educational resources.

PARLIAMENTARY LINKS DAY

This event, also organized by the Royal Society of Chemistry is the largest scientific event held annually in the Houses of Parliament. This year's event, held in June, was particularly interesting following the changeover of government.

Parliamentary Links day gives the opportunity for scientific societies and organizations, including the Royal Society, the Institute of Physics, the Society of Biology, the Campaign for Science and Engineering (CaSE) and, of course, SGM, among others to take their messages directly to parliamentarians. Many speakers from the scientific community stood up to talk about how science and engineering can work together with parliament to tackle major global issues such as climate change, energy and public health. Dr Mark Downs from the Society of Biology gave a convincing speech about how biologists are collaborating with scientists from other disciplines to tackle global issues such as the ageing population and food security. He argued that the government must continue to invest in science for the UK to maintain its leading edge. A keynote address from David Willets, Minister of State for Universities and Science, described how increased dialogue with the scientific community had already led to some important changes, such as the reissuing of the Ministerial Code with explicit reference to the importance of following the principles of scientific advice in policy making.

A video stream of the event is available at **www.rsc.org/ScienceAndTechnology/Parliament/Events/LinksDay2010.asp**

DELIVERING ON 2020

Also in June, SGM exhibited at the *Delivering on 2020* event in Scotland, designed to examine how Scotland, the UK and the rest of the world can work together to meet the climate change targets of 2020. The event was organized by *Holyrood* magazine, a publication for political and policy news in Scotland, and was held at Our Dynamic Earth in Edinburgh. Many of the delegates were surprised to see SGM in the exhibition, which confirmed our suspicions that the role of microbes in climate change was often overlooked!

CASE WORKSHOP

In July, members of the Campaign for Science and Engineering (CaSE) were invited to gather at Charles Darwin house to discuss the government's Comprehensive Spending Review in October. About 40 representatives from different scientific organizations got together to discuss what stance the scientific community should adopt in the face of potential cuts to science funding. Workshop attendees split into three discussion groups to debate whether it was worth indicating to government which areas of science should be prioritized for funding.

SCIENCE ONLINE CONFERENCE

In September, SGM went to the *Science Online London* conference where former MP Dr Evan Harris spoke about how online science lobbying can be turned into real world policy change. The fruitful breakout discussion that followed analysed the *Science Vote* campaign, launched before the election by CasE, with the goal of getting the three main parties to take science seriously.

LAURA UDAKIS is SGM Press and Public Affairs Administrator

You may think that vampires are creatures of myth and legend, but recently they have proved very useful for introducing the public in Manchester to the concepts of infectious disease and its treatment!

Having survived a vampire bite, the author (centre!) is attacked by two of *Dr Who*'s enemies. *Jo Verran*

The microbiology of VAMPIRES

"Very interesting talk. My brother now knows how much he infects us when he sneezes."

"I enjoyed how the passages from the book related to the topic."

Vampirism is infectious. Once bitten, you die, or become a vampire – or you could just provide ongoing sustenance to the friendly neighbourhood bloodsucker. You can keep a vampire at bay by not inviting them into your home, wearing garlic (and plunging a stake into the heart of course!). The parallels with infectious disease are fairly obvious (aren't they?) … so I wondered if the current interest in vampire novels and films, particularly amongst school students, could be used as a hook to discuss issues around infectious disease and microbiology.

Carole Anne Duffy, Poet Laureate and academic at MMU, was part of a team that initiated and delivered the first Manchester Children's Book Festival in summer 2010. The event was spread over a week, with the weekend comprising readings, activities and performances by some very well-known children's authors. Characters in costume walked around the public space – the screams revealing the whereabouts of the Doctor Who baddies.

I provided an MMU science slant via the *Twilight* vampire novels. I was really thankful that Dariel Burdass from Marlborough House helped me – it was something really new for both of us. Our *Twilight* event took place in a room that was set up as a lab, with lab coats and microscopes for all participants. In *Twilight*, Bella and Edward (the vampire) met over a microscope, studying phases of the cell cycle, so we did the same.

After introductions, we asked our audience how Edward became a vampire (he was dying of influenza in 1918 and was saved by another vampire). That led on to discussions of symptoms, transmission and prevention of influenza, demonstrated by a simulated sneeze and a spray of luminous liquid, courtesy of SGM. We also had readings from *Twilight*, beautifully delivered by an MMU acting graduate, initially describing Bella and Edward's two meetings over the microscope. We then used UV lamps to show how the dye was spread around the room during the event (passing around cards describing the cell cycle, looking down microscopes, etc.), leading to discussion on disease transmission generally – inhalation, ingestion, direct contact – and puncture!

"Loved the link between science and literature."

The final reading described how Edward had to suck poison from Bella after she had been attacked by another vampire, which enabled discussion to focus on treatment and prevention.

Everyone left happy, with a vampire bite temporary tattoo, and with SGM information on hand hygiene and influenza.

We ran the session three times. The audience varied from female fans and huge experts on all things *Twilight*, to families interested in science, grandparents and very young children – so conversations differed enormously as well. Feedback was good.

I would really like to thank Dariel for being there and for her partnership. Also, SGM material made the activities much more real and exciting. I have done similar activities with 15- to 16-year-olds, asking them to consider which diseases most resembled vampirism, and to suggest appropriate learning activities. I have also been invited to repeat the Festival event during Manchester Science Festival. Interest in *Twilight* is likely to be transient, but it was fun to explore how children's literature could be used in science education: there is plenty of potential for more. It just goes to show how ubiquitous microbiology is – but we all knew that anyway!

"That was so interesting. I learnt loads."

"Jeurms go ewerywhere." (sic)

"How to treat deseaseses." (sic)

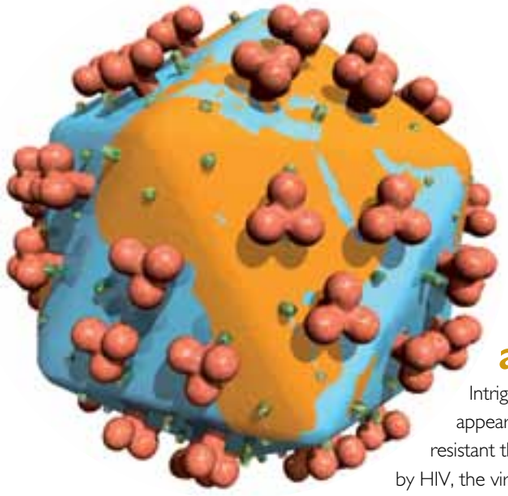
"Young people were totally engaged throughout the workshop. There was a good balance of interactivity."

"Different forms of transmission – marvellous."

"I have loved this workshop. I have learnt loads about the spread of infection. I love Twilight."

While Jo is elsewhere, Dariel gets some help at the registration desk! *Jo Verran*

JO VERRAN is SGM Education and Public Affairs Officer, Department of Biology, Chemistry and Health Science, Manchester Metropolitan University, Chester Street, Manchester M1 5GD (email j.verran@mmu.ac.uk)



The worldwide spread of HIV. *Laguna Design / Science Photo Library*

Vaginal microflora protects against HIV

Intriguingly, some women appear to be much more resistant than others to infection by HIV, the virus that results in AIDS in humans. Despite having unprotected sex with many different men, a small group of sex workers in Nairobi, Kenya, have remained uninfected for up to 15 years. Although there may be an initial infection of HIV-1 in the vagina, this does not persist or spread throughout the body. Scientists have long wanted to know the basis of this natural defence, to see if it can be extended to all. It does not seem to be an acquired immune response or rely on the women's genetics. The implication is therefore that there is something special about the natural environment within the women's vaginas and perhaps their innate immune response.

A group of researchers at the Tokyo Medical and Dental University, Japan, led by Mari Kannagi, have now followed up this idea. The normal healthy state of the innate immune system is intimately linked to the presence of bacteria on the body's surfaces. The researchers wondered if any specific bacteria provided protection against HIV-1. The mechanism might well involve the toll-like receptors (TLRs) on the human cell surface since these are required for recognition of bacteria. Human cells have up to 11 TLRs and each one recognizes different molecules. The TLRs then direct a series of countermeasures that injure or kill the pathogen. Some molecules recognized by TLRs inhibit HIV-1 replication in laboratory cell cultures.

In a series of experiments using cultures of human cells modified to glow as an indication that HIV-1 replication could be underway, they found that some bacteria had a distinctly inhibitory effect. For example, *Escherichia coli* suppressed HIV-1, although it is not normally found within the vagina. Two normal members of the vaginal bacterial community, *Neisseria mucosa* and *Veillonella parvula* were even better at suppressing HIV-1. *Lactobacillus acidophilus* could reduce replication of HIV-1, but only when it was present simultaneously with the arrival of the virus. Other species such as *Prevotella melaninogenica* actually enhanced HIV-1 expression.

The difference may be due to interaction between the TLRs on the human cells and precise liposaccharide molecules within the bacterial cell walls. The researchers discovered that if signals from the bacteria were perceived by TLR4, the result was activation of the innate immune system to produce interferon and pro-inflammatory cytokines, and inhibition of HIV-1. However, if the bacterial signals reached TLR2, the virus was not suppressed. The macrophage cells were crucial in this process.

The exciting outcome of this work is a hint that the normal commensal bacteria may contribute to natural resistance to HIV-1 infection. The possibility that harmless bacteria can be developed to give even the slightest protection against the deadly disease AIDS is too important to miss.

Ahmed, N., Hayashi, T., Hasegawa, A., Furukawa, H., Okamura, N., Chida, T., Masuda, T. & Kannagi, M. (2010). Suppression of human immunodeficiency virus type-1 (HIV-1) replication in macrophages by commensal bacteria preferentially stimulating toll-like receptor 4. *J Gen Virol* 91, 2804–2813.

MERIEL JONES HIGHLIGHTS HOT PAPERS IN RECENT SGM JOURNALS

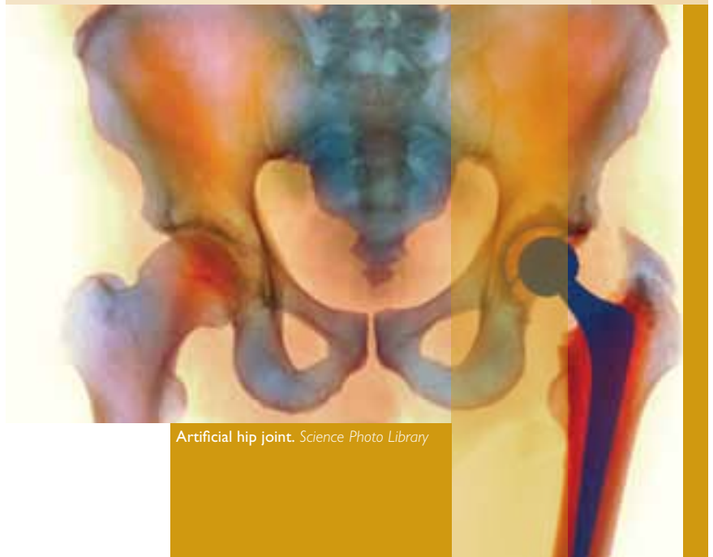
Subbiahdoss, G., Kuijer, R., Busscher, H.J. & van der Mei, H.C. (2010). Mammalian cell growth versus biofilm formation on biomaterial surfaces in an *in vitro* post-operative contamination model. *Microbiology* 156, 3073–3078.

The race for the surface

Replacing damaged bones with metal, ceramic and plastic implants works, but improvements are still needed. Successful integration of an implant into the bone and tissue requires the human cells to grow and cover the surface. Unfortunately, implants can become contaminated with bacteria, either from contamination during a lengthy operation or later due to bacteria circulating in the blood stream. Even something as routine as a dental inspection soon after an operation can cause bacterial colonization of an implant. This has led to the idea of a 'race for the surface' between the human and bacterial cells based on clinical observations. The consequences of bacteria winning can be very serious since they grow as a film over the implant surface preventing integration with the human tissue, secreting toxins and causing inflammation and pain. The otherwise harmless species *Staphylococcus epidermidis* from the skin is often the colonizing bacterium. Antibiotic treatment frequently does not work and the only solution is to remove the implant, so continuing the medical problem.

Researchers led by Henny C. Van der Mei and Henk J. Busscher in the Department of Biomedical Engineering at the University of Groningen in the Netherlands have now demonstrated an experimental basis for the 'race for the surface' theory. Their laboratory experiments allowed cultured human cells, *S. epidermidis* and a culture fluid to flow over a poly(methylmethacrylate) (PMMA) surface. This material is in widespread use, e.g. as a cement for fixing implants like hip joints. Their bacterial strain originated from the blood of a patient with an infected intravascular catheter, demonstrating that it could colonize implant surfaces.

In their experiments they first let the human cells grow over the surface to different extents and then added bacteria at levels commonly found in infections after operations. Their experiments showed that a critical level of coverage by mammalian cells is needed to protect the implant effectively against bacteria. Once this level is reached, the bacteria cannot impair the growth of the human cells. The researchers speculated that the exact level of coverage could depend on the biomaterial and bacterial strain. Their method now provides a tool to test the hypothesis and to select biomaterials colonized most efficiently by human cells so that implants integrate effectively into patients.



Artificial hip joint. *Science Photo Library*

How clean is your bronchoscope?

Bronchoscopes are flexible, slender tubes containing a light and miniature camera used to view inside the airways of the lungs. Devices to remove biopsies, foreign objects or liquid can be used through them. They have to be clean and sterile for every patient to avoid transmitting infections or giving misleading results. The strategies to wash and disinfect these complex and rather delicate devices must be harsh enough to do the job without damaging the bronchoscope. As a consequence there are regular reports of contaminants surviving to reappear in samples from patients. Joseph O. Falkinham III at the Virginia Polytechnic Institute and State University, USA, was particularly intrigued by the regular reports of non-tuberculous mycobacteria (NTM) apparently present within the lungs of patients who had none of the typical symptoms of infection. NTM are well known to be particularly resistant to some chemicals used to clean bronchoscopes.

Two species of mycobacteria cause serious diseases (tuberculosis and leprosy), but over 100 additional species are widely distributed in the environment. They were thought to be harmless but are now known to cause disease, especially in patients with pre-existing lung conditions or AIDS. Many reports of NTM are tracked back to bronchoscopes that have been inadequately cleaned between patients or become contaminated during cleaning. However, there have been few studies that have shown definitively the source of the contamination. To do this requires detailed typing of the NTM isolate, and this is not easy because of the very large genetic diversity within each NTM species. In addition, samples are needed from stages in bronchoscope washing and disinfection to pin-point whether there is a specific source of contamination that should be removed. Working with technical assistance from Myra D. Williams, the author obtained and characterized samples from all stages in the process of cleaning bronchoscopes at one hospital. Most of the samples were, of course, free of bacteria, but the stages at which they recovered NTM bacteria indicated the sources of the problem. The detailed characterization of the bacterial

HOT OFF THE PRESS

isolates allowed no doubt that the hot and cold water supplies to the laboratory were contaminated. In addition, filters that were intended to trap and remove NTM had become saturated and were sources of bacteria. The filters included non-microbiological filters in the water supply that had been unchanged for more than 6 months. The species *Mycobacterium avium* was particularly able to colonize these cartridge-type filters and was then slowly released into the water, contaminating the bronchoscopes. With this evidence, a new protocol for cleaning bronchoscopes was introduced. Removing the bacteria in the water supplies was one very obvious task. The solution included placing bacteria-proof filters on all the taps providing water for washing the bronchoscopes, planning to change them every 3 weeks as suggested by the manufacturers. In addition, UV sterilization was introduced. The result was that the numbers of NTM dropped below detectable levels and was a very successful conclusion to this piece of detective work.

Falkinham, III, J.O. (2010). Hospital water filters as a source of *Mycobacterium avium* complex. *J Med Microbiol* 59, 1198–1202.

Novel *Weissella* species from cassava and chocolate

The unifying characteristic of the lactic acid bacteria is that they can ferment carbohydrates to produce lactic acid and then continue to grow since they can tolerate acidity in their environment. One consequence of this ability is that this group of bacteria is involved in production of a surprisingly large number of foods. This includes many made from milk, like yoghurt, cheese and buttermilk, but also meat and vegetable products like sauerkraut and sausages, as well as some pickles and wines. Less well known fermentations involving lactic acid bacteria involve the fermentation of cocoa beans and pulp at the start of the production of chocolate and also products from cassava.

Researchers led by Peter Vandamme from the Laboratory of Microbiology at Ghent University and Luc De Vuyst from the Research Group of Industrial Microbiology and Food Biotechnology at Vrije Universiteit Brussel, both from the Flanders Research Consortium on Fermented Foods and Beverages (Belgium), isolated hundreds of different types of lactic acid bacteria from fermenting cocoa bean heaps in Ghana in 2004. As they used a battery of molecular biology and biochemical tests on the bacteria, a few isolates began to stand out because they differed from known species. The researchers have now followed up some of these isolates, and identified a new species they have named *Weissella fabaria*. Its activities form part of the complex process that converts bitter-tasting beans into the rich and pleasant flavour of chocolate.

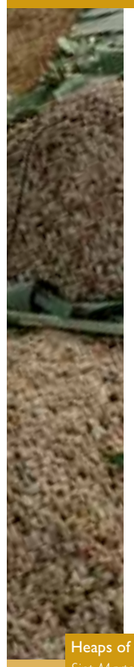
Another research group, led by Dennis S. Nielsen from the University of Copenhagen in Denmark, but with collaborators in Germany and Benin, has been investigating cassava products. This root crop forms a major part of the diet in many African countries, but as it contains two cyanogenic glucosides, linamarin and lotaustralin, it has to be processed, often by fermentation, to avoid cyanide poisoning.

De Bruyne, K., Camu, N., De Vuyst, L. & Vandamme, P. (2010). *Weissella fabaria* sp. nov., from a Ghanaian cocoa fermentation. *Int J Syst Evol Microbiol* 60, 1999–2005.

Padonou, S.W., Schillinger, U., Nielsen, D.S., Franz, C.M.A.P., Hansen, M., Hounhouigan, J.D., Nago, M.C. & Jakobsen, M. (2010). *Weissella beninensis* sp. nov., a motile lactic acid bacterium from submerged cassava fermentations, and emended description of the genus *Weissella*. *Int J Syst Evol Microbiol* 60, 2193–2198.

Cassava is made into many fermented foods, such as gari, agbelima and lafun. Lactic acid bacteria play a major role in such fermentations and the researchers have isolated a novel and unusual species, *W. beninensis*, from lafun. To make traditional lafun, pieces of cassava are steeped in water for about 4 days, and then crushed by hand. By this time, bacteria have grown on it and changed the flavour and texture. To make the final product, water is pressed out of the paste, and then the lafun is dried and ground to a powder before use in cookery.

The unusual feature of *W. beninensis* is that it can swim. Lactic acid bacteria normally cannot move around so this new species extends the characteristics of the *Weissella* genus of bacteria.



Heaps of fermenting cocoa beans. *Katrien De Bruyne, Applied Maths NV, Sint-Martens-Latem, Belgium*

Essential Plant Pathology, 2nd edn

Editors G.L. Schumann & C.J. D'Arcy
Publisher American Phytopathological Society Press (2010)
Details US$89.95 | pp. 384 | ISBN 978-0-89054-381-8
Reviewer Gerry Saddler, Science & Advice for Scottish Agriculture

This is quite simply an excellent book! Bizarrely, this statement in itself fails to do it justice, as this is considerably more than just a book. The CD-ROM tucked in the back cover allows the reader to explore in greater depth case studies, gives access to countless images, tests your understanding of the main topics and provides hotlinks to relevant websites. It's undoubtedly written with the undergraduate in mind, and its pitch is very much at the practical, applied level. Those wishing to know more about molecular plant–pathogen interactions, genomics, diagnostics, etc., should look elsewhere. However, this should not be seen as a criticism as their inclusion would either considerably lengthen the text or dilute its content. I have no hesitation in recommending this book, which considering all that it does, is competitively priced at around £60. The only problem I see is that with the ever-dwindling number of universities still teaching plant pathology to undergraduates (at least in the UK), who's going to buy it?

Caliciviruses: Molecular and Cellular Virology

Editors G.S. Hansman, X.J. Jiang & K.Y. Green
Publisher Caister Academic Press (2010)
Details £159.00 | pp. 248 | ISBN 978-1-90445-563-9
Reviewer Ulrich Desselberger, Cambridge

Noro- and sapoviruses, two genera of the Caliciviridae family, are increasingly recognized as major human pathogens, causing most outbreaks and many sporadic cases of non-bacterial acute gastroenteritis. Major progress has been made in the study of the molecular biology of these viruses over the past 10–15 years, and the most important findings are reviewed here by experts in the field. The epidemiology is characterized by the ubiquitous nature of the Caliciviridae, their very low infectious dose and their ability to persist in the environment. Double infections lead to the formation of highly fit recombinant viruses. Viral protein and particle structures, virus–host cell receptor interactions, and viral protein processing have been studied in viruses replicating in infected cells. Reverse genetics (RG) systems have been developed for some, although not all of the Caliciviridae. Viral pathogenesis has been explored in suitable animal models. A murine norovirus which replicates in macrophages and for which several RG systems exist has become particularly prominent. All chapters are carefully and clearly written, and supported by references reaching well into 2009.

This book is a splendid example of how fast a research field which has been beset by many difficulties for a long time can move and create excitement. The book is highly recommended to specialized virologists and molecular biologists, but also to epidemiologists, infectious disease and general physicians, and to all interested students of biomedical/microbial sciences.

Infections of Leisure, 4th edn

Editor D. Schlossberg
Publisher American Society for Microbiology (2009)
Details US$69.95 | pp. 448 | ISBN 978-1-55581-484-7
Reviewer Ian McCrone, University of Cambridge

It is hard to believe that such a small text can contain so much information, thoroughly covering a vast array of infectious hazards that are associated with all sorts of leisure activities. These are well laid out in chapters covering an intriguing range of exposures from both salt- and freshwater activities, camping, gardening, zoonotic risks due to contact with pets, wildlife and petting zoos, sports, foreign travel, sexually transmitted diseases, trekking and climbing at high altitude, tattooing and body piercing, and risks from exotic foods. It would appear that leisure time is dangerous and perhaps it is safer to stay at work, but the book does explain the risks well, and judging by the large number of references is certainly well-researched and evidence-based. In summary, the book is up-to-date, concise, well-presented and is an enjoyable read that should appeal to clinicians, scientists or anyone else with an interest in infectious disease.

Functional Glycomics: Methods and Protocols

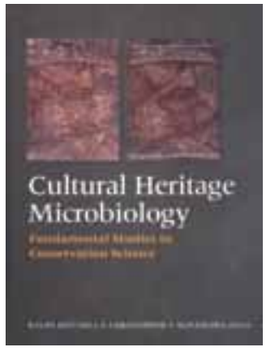
Editor J. Li
Publisher Humana Press (2009)
Details £72.00 | pp. 281 | ISBN 978-1-60761-453-1
Reviewer Sheila Patrick, Queen's University, Belfast

This book provides a useful introduction to the field of glycobiology as well as detailed protocols relating to methods of analyses. The analysis of the components and sugar sequences of oligosaccharides and polysaccharides is a far more difficult issue than protein analyses, and perhaps for this reason glycobiology has lagged behind protein biology. As a result, the importance of glycan–protein interaction in both eukaryotic cellular interactions and pathogen–host interactions seems to have been historically overlooked. While the focus of this book is largely on glycoprotein analysis, there are short sections on lipopolysaccharides, although no coverage of capsular polysaccharides. The application of mass spectrometric analysis to determining O-antigen glycoforms and serotype relationships is of particular interest. In addition, the growing list of prokaryotic glycoproteins means that there is much of relevance to the microbiologist who is considering exploring this field and wishes to gain an understanding of current methodologies.

Cultural Heritage Microbiology: Fundamental Studies in Conservation Science

Editors R. Mitchell & C.J. McNamara
Publisher American Society for Microbiology (2010)
Details US$169.95 | pp. 348 | ISBN 978-1-55581-476-2
Reviewer Jo Verran, Manchester Metropolitan University

The title of the book clearly states its intent. It comprises six sections, each addressing a different substrate that forms part of cultural heritage, as well as microbiological degradation: painted materials, paper and manuscripts, textiles, synthetic polymers, wood and stone.



Each section consists of an introductory chapter, followed by a number of papers written by international experts in that particular field, previously published in other journals (back as far as 1991!). Thus the Editors have collated presumably seminal works for each of these areas, to provide an overview of the current state of knowledge. The age of some of the publications perhaps illustrates that there are few researchers in these fields, and perhaps little funding. I would imagine a potential reader to be one of a small group with a broad interest in applied microbiology, archaeology and history, or with a particular appetite for preliminary literature searching in a specific application. Apart from the introductory chapters, those microbiologists who are carrying out relevant research would presumably already be aware of key papers, thus information will not be new, and interest in other substrates would be cursory. A final potential audience might be researchers for whom the substrate, rather than the cultural heritage status, is of importance. For example, the chapter on textiles includes work on the deterioration of synthetic material used in spacesuits; and synthetic polymers used in paints, addressed in another chapter, are clearly of relevance to the entire current coatings industry.

To a microbiologist whose interest is not directly in these fields, the book (although weighty and expensive) provides a fascinating insight into a different area of applied microbiology, interesting examples of biofilms, and evidence of translation of state-of-the-art methodologies, such as molecular approaches to identification of microbial consortia, into novel arenas. The global significance of cultural heritage is apparent throughout, and the book flags an internationally important resource. Colour plates are most informative, and contribute to the overall impression of the book itself as a significant cultural tome.

Controlling microbial growth on heritage material is a major challenge, because an appropriate method to stop invasion without provoking secondary succession and biodeterioration is a must (paraphrased from Saiz-Jimenez, Chapter 1). The importance of microbiology to the health of the materials that record and represent history, archaeology and culture is significant. Knowledge of mechanisms of deterioration, approaches to preservation and conservation need to be recorded, and recounted to the multidisciplinary audiences of professional curators, conservators, etc. – but this publication does not really do this at an appropriate level. In the past, more manageable texts have been published – perhaps it is time for another!

Reviews on the web

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

Medical Microbiology
Editor M. Ford
Publisher Oxford University Press (2010)
ISBN 978-0-19954-963-4

Infection and Immunity, 3rd edn
Authors J. Playfair & G. Bancroft
Publisher Oxford University Press (2008)
ISBN 978-0-19920-673-5

Evolution of Organellar Metabolism in Unicellular Eukaryotes
Editors M.L. Ginger, G.I. McFadden & P.A.M. Michels
Publisher The Royal Society (2010)
ISBN 978-085403-808-4

Manual of Industrial Microbiology and Biotechnology, 3rd edn
Editors R.H. Baltz, J.E. Davies & A.L. Demain
Publisher American Society for Microbiology (2010)
ISBN 978-1-55581-512-7

Microbial Ecology of Activated Sludge
Editors R. Seviour & P.H. Nielsen
Publisher IWA Publishing (2010)
ISBN 978-1-84339-032-9

Management of Antimicrobials in Infectious Disease: Impact of Antibiotic Resistance, 2nd edn
Editors A.G. Mainous & C. Pomeroy
Publisher Humana Press (2010)
ISBN 978-1-60327-238-4

Functional Biochemistry in Health and Disease
Authors E. Newsholme & T. Leech
Publisher John Wiley & Sons Limited (2010)
ISBN 978-0-471-98820-5

Molecular and Cell Biology Methods for Fungi
Editor A. Sharon
Publisher Humana Press (2010)
ISBN 978-1-60761-610-8

***Malassezia* and the Skin**
Editors T. Boekhout, E. Gueho, P. Mayser & A. Velegraki
Publisher Springer-Verlag GmbH & Co. KG (2010)
ISBN 978-3-64203-615-6

Fundamentals of Inflammation
Editors C.N. Serhan, P.A. Ward & D.W. Gilroy
Publisher Cambridge University Press (2010)
ISBN 978-0-52188-729-8

To join our panel of book reviewers, email **y.taylor@sgm.ac.uk**

Officers

- **President – Prof. Hilary M. Lappin-Scott**
  Singleton Abbey, Swansea University, Singleton Park, Swansea SA2 8PP
  email **h.m.lappin-scott@swansea.ac.uk**
- **Treasurer – Prof. Colin R. Harwood**
  Centre for Bacterial Cell Biology, Institute for Cell and Molecular Biosciences, Baddiley Building, University of Newcastle, Newcastle upon Tyne NE2 4AX
  tel. 0191 208 3221; fax 0191 222 7736
  email **colin.harwood@ncl.ac.uk**
- **General Secretary – Prof. David J. Blackbourn**
  University of Birmingham, Cancer Research UK Institute for Cancer Studies, Edgbaston, Birmingham B15 2TT
  tel. 0121 415 8804; fax 0121 414 4486
  email **d.j.blackbourn@bham.ac.uk**
- **Scientific Meetings Officer – Prof. Christopher J. Hewitt**
  Department of Chemical Engineering, Loughborough University, Loughborough LE11 3TU
  tel. 01509 222506; email **c.j.hewitt@lboro.ac.uk**
- **Education and Public Affairs Officer – Prof. Joanna Verran**
  Department of Biology, Chemistry and Health Science, Manchester Metropolitan University, Chester Street, Manchester M1 5GD
  tel. 0161 247 1206; fax 0161 247 6325
  email **j.verran@mmu.ac.uk**
- **Publications Officer – Prof. Howard Jenkinson**
  Department of Oral and Dental Science, University of Bristol, Lower Maudlin Street, Bristol BS1 2LY
  tel. 0117 928 4358; email **howard.jenkinson@bristol.ac.uk**

Members

- **Prof. Nigel L. Brown** College of Science & Engineering, Weir Building, King's Buildings, University of Edinburgh, Edinburgh EH9 3JY
  tel. 0131 650 5754; fax 0131 650 5738
  email **nigel.brown@ed.ac.uk**
- **Dr Kim R. Hardie** Centre for Biomolecular Sciences, University of Nottingham, University Park, Nottingham NG7 2RD
  tel. 0115 846 7958; fax 0115 586 7950
  email **kim.hardie@nottingham.ac.uk**
- **Prof. Mark Harris** Institute of Molecular & Cellular Microbiology, Faculty of Biological Sciences, University of Leeds, Leeds LS2 9JT
  tel. 0113 343 5632; email **m.harris@leeds.ac.uk**
- **Dr Paul A. Hoskisson (Editor *Microbiology Today*)** Strathclyde Institute of Pharmacy & Biomedical Sciences, University of Strathclyde, 204 George Street, Glasgow G1 1XW
  tel. 0141 548 2819; email **paul.hoskisson@strath.ac.uk**
- **Dr Karen Robinson** Centre for Biomolecular Sciences, University of Nottingham, University Park, Nottingham NG7 2RD
  tel. 0115 823 1094; email **karen.robinson@nottingham.ac.uk**
- **Dr Gary Rowley** School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ
  tel. 01603 592889; email **g.rowley@uea.ac.uk**
- **Prof. John H. Sinclair** Department of Medicine, Level 5, Laboratory Block, Addenbrooke's Hospital, Hills Road, Cambridge CB2 0QQ
  tel. 01223 336850; fax 01223 336846
  email **js@mole.bio.cam.ac.uk**

DEAR EDITOR

We read with interest the article concerning the status and long-term future of UK and European culture collections in the August 2010 issue of *Microbiology Today* [**37**(3) p. 200].

It is correct that collections have hit difficult times, not least in the UK. Individually, culture collections are vulnerable with over 20 disappearing from the World Data Centre for Microorganisms (WDCM) in the past few years. However, some collections have been addressing this with initiatives to tackle the challenges that face them. It was not too long ago that the UK National Culture Collection (UKNCC) initiative was implemented following a review of culture collections by Whittenbury, and the strong UK Government response was admired by other countries. When UKNCC funding ceased in 2000, it was difficult to keep the momentum going and the individual policies of collection host institutions took over. Indeed, whilst trying to strengthen the network, one collection (National Collection of Wood Rotting Fungi) lost its governmental funding and transferred its holdings to the Centre for Agriculture and Biosciences International (CABI). Indeed, the CABI National Collection of Fungus Cultures had lost its funding in 1989 and has only been able to continue through the support of CABI. The UKNCC website (www.ukncc.uk.co) still provides useful information and links to the member collections' web pages to access their current holdings. The National Collections hold well in excess of 100,000 strains of microorganisms and cell cultures. The WDCM lists over 570 culture collections in 68 countries, and currently provides a global database for centralized tracking of collections, expertise and holdings.

Culture collections have existed for over 100 years. Their aim is to secure the microbial genetic pool for research in the life sciences, and to support the continued search for properties and novel products for applications in the field of medicine, nutrition and agriculture. High-quality research in the life sciences and innovative solutions to global problems requires access to high-quality biological materials and associated information. The voucher specimens and type strains that underpin taxonomy are maintained by these collections. They hold the biological resources upon which data in publications and databases, e.g. Genbank, are based, enabling confirmation of results and further work. Collections provide access to authentic reference materials to ensure research is based upon the correct organisms. Mutually beneficial strategies are needed to encourage deposition of strains into collections, particularly for all published results, and to protect the investment made in publicly funded research. The diminishing resource of specialist taxonomists makes ensuring correct identity of strains difficult and the discovery of new diversity slow and haphazard. It has been estimated that it will take 1,400 years to isolate and identify all the yet to be discovered fungi.

Modern technologies are also adding to the number of materials needed to be preserved for future use. The accession of this material into microbiological resource centres will require new expertise and greater capacity, while the very existence of some collections is under threat. Deplorably, the scientific literature is full of data which cannot be verified because the material has deteriorated or is no longer available. Consequently, more microbial collections are needed around the world, equipped with techniques and expertise to cope with the depth and breadth of emerging biodiversity; providing access to high quality biological material and scientific services while at the same time observing donor countries' rights, intellectual property rights, biosafety and biosecurity aspects. The challenge is to keep abreast of developments in taxonomy and systematics, as well as new methods for the authentication and identification, cultivation and maintenance of cultures. As this will be especially difficult on an individual basis, co-operation and harnessing the power of networking on a national, regional and global level will be the only way forward to achieve sustainable support for bioindustry. Additionally, governments who signed the Convention on Biological Diversity (CBD) have to accept their responsibility to comply with articles 9 (complement conservation efforts with *ex situ* activities) and 15 (facilitate access), by supporting those bodies (Biological Resources Centres, BRCs) that are in a position to authenticate and maintain such resources. Additional funding at a broad scale is needed, but as an investment for resource providers to deliver into bioindustry and biotechnology.

Collections strive to find ways to survive, not unlike the organisms they hold and supply. Unfortunately, the drive for financial self-sustainability has driven some collections to necessarily lose some of their public service functions. Harnessing the power of networking provides some of the answers, and activities in the UK, across Europe and globally have been bearing fruit. The World Federation for Culture Collections (WFCC) has been fighting the cause for over four decades (www.wfcc.info). In Europe, the European Culture Collections' Organization (ECCO – www.eccosite.org) has been providing an incubator for pan-European initiatives. However, much work and investment is still needed, by collections, governments and bioindustry, if the power of microbial diversity is to be harnessed effectively. Microbes are already the source of wondrous drugs and chemical products; a strategic and collaborative approach is needed to access these resources more efficiently. Micro-organisms will provide the solutions to some of the big global challenges of today – in poverty alleviation, food security, healthcare, climate change and the environment. The ECCO incubation initiatives have helped collections get support and organize themselves to help in delivery; for example, recent European Community Framework Programme projects, such as the Common Access to Biological Resources and Information (www.cabri.org), EBRCN (European Biological Resource Centres Network – www.ebrcn.net) and the European Consortium of Microbial Resource Centres (EMbaRC, www.embarc.eu). However, project funding is itself not enough; networking to improve coverage, delivering high-quality products and services will help access funds to provide a pipeline for research and the bioeconomy.

The European projects have resulted in technical guidelines and focussed information documents covering requirements with which modern-day microbial collections are challenged. Importantly, they have provided some of the basic information needed for the OECD BRC initiative which started in 1999. The recommendations of the OECD BRC Task Force towards governments, policy-makers and other stakeholders embraced the importance of safe and legitimate access to high-quality biological material for research and development. They requested that BRCs must meet the standards of quality and expertise demanded by the international community of scientists and industry for the delivery of biological information and materials that will enable research. Adequate funding is required to achieve these standards and assure sustainability. Guidance documents for the operation of such BRCs, including quality management and biosecurity as well as strategies for setting up a Global Biological Resources Centres Network (GBRCN), were the outcome of this work. As a consequence, the demonstration project for a GBRCN (www.gbrcn.org) commenced at the end of 2008, a secretariat was established funded by the German Federal Ministry of Research and Education (BMBF). In its present composition, it has partners in North and South America, Africa, Asia and a strong basis in Europe. On a global level, the project aims at building a structured, long-lasting, global network which will pave the way for collections to meet user needs. The EMbaRC project is initiating the European node of the GBRCN. Key issues addressed are biosafety, development of added-value techniques, and the improvement, co-ordination and validation of microbial resource centre protocols. It aims to optimize conservation and identification of bacteria and fungi, and the generation of high-quality DNA. It is developing a strategy to increase depositions into collections of strains described in the scientific literature.

To address future needs, the GBRCN, ECCO and EMbaRC have submitted a proposal via the French delegation to the European Strategy Forum for Research Infrastructures (ESFRI – www.ec.europaeu/research/infrastructures/index_en.cfm?pg=esfri). This proposal, the Microbial Resources Research Infrastructure (MIRRI) has been recommended for inclusion on the ESFRI road map. MIRRI brings together European microbial resource collections with their stakeholders aimed at improving access to enhanced quality microbial resources in an appropriate legal framework, thus underpinning and driving life sciences research. ESFRI are establishing pan-European structures to drive innovation to provide the resources, technologies and services as the basic tools necessary to underpin research. There are 44 research infrastructures on the 2008 ESFRI road map, each addressing a unique niche of research. Each research infrastructure (RI) is designed to deliver scientific and technological cutting edge and managerial excellence in research, education and technology, and provide clear pan-European added value. RIs are at the centre of the knowledge triangle of research, education and innovation, producing knowledge through research, diffusing it through education, and applying it through innovation.

MIRRI will be co-ordinated by the GBRCN Secretariat based in Braunschweig, Germany, and will integrate services and resources, bridging

the gap between the organism and provision of innovative solutions. MIRRI will provide coherence in the application of quality standards, homogeneity in data storage and management and sharing of workload to help to release the hidden potential of micro-organisms. MIRRI will enhance existing European microbial collections linking them to non-European country partners globally and will bring added value through:

- a coordinated strategy to provide a broader coverage of bioresources and services;
- a coordinated approach to the implementation of best practice;
- a distributed platform for microbial taxonomy to ensure best use of the remaining expertise and to put in place a human resource development programme;
- a cluster approach, focussing effort on key issues to deliver more efficiently;
- common policies across international boundaries facilitating legitimate access;
- establishing facilities and resources in countries or regions rich in microbial diversity but without resources and facilities to make them readily available for research;
- linking data across disciplines enabling data mining and targeting of specific microbial resources for specific tasks.

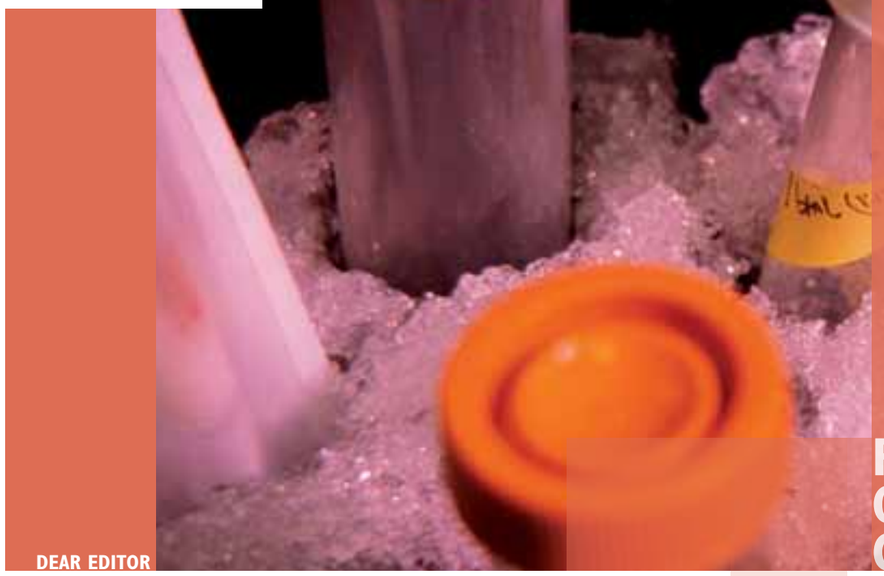
The UK collections, as all European country collections, are the foundation stones on which research and development is based. The UK collections need to partner with their European counterparts and work together, so for UKNCC read GBRCN and the future is MIRRI.

DAVID SMITH is President of the WFCC, General Manager of the GBRCN Demonstration Project, and Director of Biological Resources, CABI Europe–UK, Bakeham Lane, Egham, Surrey TW20 9TY (email d.smith@cabi.org)

DAGMAR FRITZE, GBRCN Secretariat, Julius Kühn-Institut (JKI), Institut für Pflanzenernährung und Bodenkunde, D-38116 Braunschweig, Germany (email dfr@dsmz.de)

ACKNOWLEDGEMENTS TO PROJECT FUNDERS

EMbaRC project, supported by the EU Seventh Framework Programme Research Infrastructures (INFRA-2008-1.1.2.9), BRCs for micro-organisms (grant agreement number FP7-228310), GBRCN and the Bundesministerium für Bildung und Forschung (BMBF) (the German Federal Ministry of Education and Research).



DEAR EDITOR

RESPONSIBILITIES OF CULTURE COLLECTIONS

Photodisc / Thinkstock

The recent reports on the decline in microbial culture collections/Biological Resource Centres by Paul Hoskisson [August 2010 issue of *Microbiology Today*, **37**(3), p. 200] and recent measures to strengthen their position through the establishment of a Global BRC Network by David Smith and Dagmar Fritze (see the letter above) are worth promoting to a broad auditorium of stakeholders, i.e. scientists, editors, curators and funding organizations of both public collections and research. The latter authors cited the almost complete lack of deposition into public collections of strains used in the scientific literature. I would like to add two other components which are central to the responsibilities of culture collections.

First, collections are centres of excellence for taxonomic research, maintaining and providing strains under optimal authentic conditions and, if organized such as the collections in West Europe or East Asia, are one-stop-shops for highly authentic material. Nevertheless, the majority of researchers do not take advantage of the availability of reference material, but rather include references from neighbouring laboratories, colleagues or in-house collections run under questionable quality systems. Of 20,200 prokaryotic research strains in 835 articles in eight European journals in 2008 only 18% (1,173) of these could be traced back to public collections by their acronyms (Stackebrandt, 2010). In contrast, the ratio is reversed in the *International Journal of Systematic and Evolutionary Microbiology*, a journal with a rigorous reviewing system in place concerning the origin of reference material: of the 1,170 prokaryotic references in 2008, 86% of strains were provided by public collections. The unwillingness of authors to deposit strains and to provide these strains to colleagues, together with the low percentage of authenticated reference strains makes validation of published data cumbersome and constrains the distribution of strains worthy of long-term maintenance. Certainly, the peer-review system would gain credibility with a more transparent origin and authenticity of such references.

Second, an undetermined number of research collections exist that for various reasons may demand transfer in totality or part into public collections for long-term maintenance. Though public collections should accommodate these holdings, there are severe obstacles. Working already at the limits of their capacities these repositories cannot accommodate large strain collections without accompanying basic information on their content, such as country of origin of isolates, documents on prior informed consent (PIC, for strains isolated after 1995), geographic co-ordinates, names of the person who isolated and identified the samples and, not to be ignored, basic information of the taxonomic status of isolates (at least to the genus level). Scientists should not depend on curators to perform proper identification of strains which may have been isolated decades ago.

Scientists have to justify demands for expendable items for research and publishing (e.g. in open access journals) to their granting agencies, but most probably these costs will not include money for the identification, maintenance and curation of their own strain collections. It may be that not only scientists but also research agencies have to be blamed for their ignorance towards one of the priority areas of science, i.e. proper authentification and maintenance as the basis of research in microbiology. While often astronomical expenses (explainable, indeed) are provided to scientists to recover microbial isolates (e.g. from polar regions, deserts, deep sea and high-altitude environments) the contingent for proper analysis, safe and long-term maintenance of isolated biological material is trivial. This attitude must change and must consider that any isolate is a unique, unrecoverable, high-added-value biological resource, its waste being unjustifiable in times of increasing awareness of the value of bioeconomy. The public collections of micro-organisms and their grant agencies, are only two stakeholders that fully appreciate the value of microbial resources. Now the time has come to initiate an intense dialogue with all stakeholders involved in order to safeguard precious resources by stronger support, conceptual and financial, of systematics, long-term preservation methods and expansion of taxonomic expertise.

ERKO STACKEBRANDT, DSMZ – German Collection of Micro-organisms and Cell Cultures, Braunschweig, Germany (email erko@dsmz.de)

REFERENCE

Stackebrandt, E. (2010). Diversification and focusing: strategies of microbial culture collections. *Trends Microbiol* 18, 283–287.

This communication is an initiative of EMbaRC, supported by the EU Seventh Framework Programme (FP7, 2007–2013), Research Infrastructures action, under the grant agreement no. FP7-228310.

EFSA – Why we should be worried

Hemera / Thinkstock

How effective is the European Food Safety Authority (EFSA) in reviewing the science behind EU legislation covering pre- and probiotics in food, and could EFSA claims be damaging the functional food industry in Europe?

BOB RASTALL

IN RECENT YEARS there has been a rise of 'functional food' products designed to have specific health benefits. The largest sector is probiotics including supplements, yoghurts and fermented milk drinks. Manufacturers would like to make specific health claims for such products where there is science to support them, but until recently this has not been allowed.

In 2006, new health claim legislation came into force in the EU. The agency tasked with evaluating the science behind the claims is the European Food Safety Authority (EFSA). Their opinions will subsequently be legislated by the EU and member states. The aim is a system for legislation of functional foods that will protect consumers from unsupported health claims. Claims fall into one of three categories. Article 13.1 claims are on body function effects based on existing science. Companies provide lists of published references and other supporting information. Article 13.5 claims are on body function effects based on emerging science. Companies provide a dossier of evidence for the claim. Article 14 claims are for disease risk reduction claims and claims involving children.

To date, EFSA have rejected the majority of probiotic claims and both prebiotic claims submitted. These rejections are a cause for concern. Although some have been rejected on the grounds that the body of scientific evidence submitted was not sufficient to allow the claim, most probiotic claims have been rejected on the basis that the strains involved were not adequately characterized; however, the science behind these health claims was not assessed. This situation has arisen as EFSA did not provide clear guidelines in the first instance over what level of characterization was required.

A fundamental question is the level of substantiation that EFSA should be requiring. Whilst it is essential that the science behind health claims is good, it is important to keep in mind that functional foods are not drugs but occupy a 'grey area'; they can reduce risk, incidence or severity of disease to some degree; they are not preventative or curative. Should we expect pharmaceutical standards of claim substantiation for an inexpensive food product producing, say, a 10% reduction in disease risk? Is it unreasonable to expect a high-volume, low-margin sector such as the food industry to provide this? Or should we demand the very highest level of substantiation for any agent that impacts on health?

In some cases EFSA has criticized study designs that have been accepted in high-quality, peer-reviewed journals, but have not, until now, provided clear guidance as to what is required to achieve a positive opinion. EFSA have recently published draft guidance on the scientific requirements for health claims on gut and immune function to be discussed by experts. It addresses (i) which claimed effects are beneficial physiological effects; and (ii) which studies/outcome measures are appropriate for the substantiation of function claims and disease risk reduction claims?

The guidance given is not encouraging for companies wishing to make claims based on gut microbiota modulation as EFSA does not consider that a change in the microbiota is, in itself, a health benefit. They do consider reduction of specific pathogens by more than one log and reduction of toxins as a health benefit. The guidance does not provide any biological justification for these.

Many probiotic and some prebiotic studies have aimed to improve immune function measuring a variety of markers, e.g. cytokines, chemokines and antibody titres. Again, EFSA do not consider these as health benefits in themselves.

Why should we be worried about the EFSA processes? It is clear that the article 13.1 route is not working for probiotics and prebiotics, and this is likely to push companies towards 13.5 dossiers. This may have consequences for industry-funded academic research as companies focus more on the EFSA claim than on high-quality publications. It also means that EFSA decisions could be based on unpublished research, reducing the transparency of the process.

The functional food industry in Europe has been damaged already as a result of the negative opinions and the attendant negative press coverage. There is a risk of companies not putting their products through the process and not making claims, focussing their functional food development towards more amenable regions or ignoring EFSA completely and making claims regardless. It is not clear how EU consumers will be better off as a result.

BOB RASTALL, Dept of Food & Nutritional Sciences, University of Reading, PO Box 226, Whiteknights, Reading RG6 6AP (email r.a.rastall@reading.ac.uk)