

# MICROBIOLOGY TODAY

QUARTERLY MAGAZINE OF THE SOCIETY FOR GENERAL MICROBIOLOGY

38:1 FEB 2011



LESSONS FROM PLAGUE  
LONG 'LIVE' THE VIRUS  
EMERGING FUNGAL  
PATHOGENS  
LEISHMANIA RE-EMERGING  
TB: FORGOTTEN BUT  
NOT GONE

EMERGENT AND RESURGENT PATHOGENS





#### COVER IMAGE

A victim of plague taken from a 15th century German woodcut. Science Photo Library

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## FEATURES

### 14



#### The power of hindsight: lessons from plague

PETRA OYSTON

What can the transmission and evolution of this unusual pathogen teach us about how we might prepare for future emergent pathogens?

### 20



#### The virus is 'dead'. Long 'live' the virus!

PAUL DUPREX & ELKE MÜHLBERGER

How do we face up to the global challenge of emerging viral infections?

### 26

#### Emerging fungal pathogens

KEN HAYNES

As the number of immunocompromised individuals grows, fungal pathogens are becoming ever more important.

### 30

#### *Leishmania* as a re-emerging pathogen

OWAIN MILLINGTON

Leishmaniasis is certainly a disease of current importance, but is there any evidence to suggest that it can be considered as a re-emerging disease?

### 34



#### Tuberculosis: forgotten but not gone

STEPHEN GILLESPIE

The world is confronted with the appearance of extremely drug-resistant strains of *Mycobacterium tuberculosis*. What is being done to combat this serious threat?

## REGULARS

### 2

#### News

SGM Prize Medal 2011  
Committee elections  
... and much more

### 10

#### Microshorts

### 12

#### Conferences

Register for Harrogate

### 42

#### Schoolzone

New resources

### 44

#### Gradline

An international career

### 50

#### Outreach

Manchester Science Festival

### 53

#### Public Affairs

House of Lords 2010

### 58

#### Going Public

The Urdd Eisteddfod

### 62

#### Hot off the Press

### 65

#### Reviews

### 67

#### Addresses

### 68

#### Comment:

Superbug harbinger?

DAVID LIVERMORE

## PLUS...

### 38

#### Peter Wildy Prize Lecture

How the mushroom got its spots and other stories

SUE ASSINDER

### 60

#### Letters

The Bt-brinjal debate



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## SGM's next Chief Executive

SGM Council has appointed **DR SIMON FESTING** as the next Chief Executive of the Society, in succession to **DR RON FRASER**, who retires in July 2010 after 15 years' service. A feature on Simon's background and aspirations for his new appointment will appear in the May issue of *Microbiology Today*.

## NEW SECTIONS IN MT

*Going Public* has been a regular feature of *MT* since 1999. The original idea behind this feature was to provide a column where activities designed to promote microbiology could be reported. However, since 1999 the role and activities of the External Relations team have expanded greatly, and a single section in the magazine no longer reflects the wide range of outreach, awareness and public affairs work that both staff and members carry out. *Going Public* will not disappear completely but, with a revised remit, it will become part of a trio of regular features:

- **Outreach** (see p. 50) – This new section will be used to describe the work of the SGM External Relations team, in particular describing projects in which SGM staff promote microbiology to and inform the general public.
- **Public Affairs** (see p. 53) – Events and activities designed to make the voice of microbiology heard by parliamentarians and policy-makers will be reported here.
- **Going Public** (see p. 58) – The new incarnation of this section will focus more on the work of members and will include reports of projects and events that have been organized with or without Society funding.

If you are a member and would like more information about how to promote microbiology to the general public and schools, the External Relations team has prepared a series of information sheets, and they are available as PDFs at [www.sgm.ac.uk/education\\_careers](http://www.sgm.ac.uk/education_careers)

## Local representatives

SGM is very grateful to our network of local representatives who provide valued support in promoting SGM grants, conferences and other activities to colleagues and students in their departments across the UK and Ireland. We thought it was time to acknowledge and publicize their excellent help so (with their permission) we have listed all active representatives on page 67.

Please check the list to see who your local representative is. If there is not one listed for your organization and you'd like to volunteer for the role, Jane Westwell ([j.westwell@sgm.ac.uk](mailto:j.westwell@sgm.ac.uk)) would be delighted to hear from you. The job is not onerous: we supply you with the latest news of SGM membership and activities a few times a year and ask you to pass it on to your colleagues.

We have thousands of members and very much appreciate our local reps' help in letting people know how to make the most of their membership.

## New media update

### FACEBOOK AND TWITTER

More and more people are getting their daily updates on upcoming SGM activities through *Facebook* and *Twitter* – via which we also give you the photos and gossip afterwards! Over 1,400 people are now connected to the SGM *Facebook* page, of whom more than two-thirds are regular users. As *Facebook* and *Twitter* are such an integral part of many people's daily lives, social media are fast becoming a one-stop shop for sharing information. We encourage you to share any news or events happening in the microbiology world by posting on our *Facebook* wall or sending us a tweet and keep the SGM online community going from strength to strength. Suggestions are welcomed for any other information you'd like to see from SGM or how often/what time of day you'd most like to see it. Leave us a comment on *Facebook*, a message on *Twitter* ([@SocGenMicro](https://twitter.com/SocGenMicro)) or even send an old-fashioned email if you prefer ([l.udakis@sgm.ac.uk](mailto:l.udakis@sgm.ac.uk))!

### PODCASTS

Ever wondered about how the health claims from the manufacturers of pro- and prebiotics are regulated? Listen to **PROFESSOR BOB RASTALL** from the University of Reading talking about the present and future for the functional food industry.

The second of our two new podcasts features **PROFESSOR WENDY BARCLAY** from Imperial College London. She tells us how she thinks public awareness and attitudes towards influenza infection and vaccination have changed since the swine flu pandemic in 2009.

All the podcasts in our *Microbe Talk* series are available on both the main SGM website [www.sgm.ac.uk/news/podcast.cfm](http://www.sgm.ac.uk/news/podcast.cfm) and our education website [www.microbiologyonline.org.uk/what-s-hot](http://www.microbiologyonline.org.uk/what-s-hot)



## IJSEM RIVALS X-FACTOR!

It's not often that microbiology overtakes reality TV gossip in the news, but recent press coverage from one of our journal papers did just that! The paper, '*Halomonas titanicae* sp. nov., a halophilic bacterium isolated from the RMS Titanic', was published in the December issue of *IJSEM*. The novel species of bacterium described was interesting because it was discovered within a 'rusticle' – a structure resembling a rusty icicle. The bacterium was found to have iron-corrosive properties and is thought to be contributing to the deterioration of the famous ocean liner. Within an hour of the press release going out, the BBC and *Guardian* were on the phone wanting more information and the BBC story was online by mid-afternoon. By that evening, the story featured at number five on *BBC Online's* 'most read' list – beating the latest news from *X-Factor*! The story was also circulated widely through the Twittersphere, with much intrigue surfacing over the word 'rusticle' – including a few amusing suggestions for alternative definitions! Who says science can't be entertaining?

Rusticles on RMS Titanic. RMS Titanic Inc.



## News of Members

**DR CAROL TURLEY**, a senior research scientist at the Plymouth Marine Laboratory, has been awarded an OBE in the 2011 New Year's Honours list for services to Science.



PML

She said, 'It has been a wonderful privilege to explore and discover how the oceans work, and to be recognized by this award is a surprise and an honour. Over the years I have collaborated with many great scientists and I hope they feel they can share this award; science is, after all, a joint endeavour that develops over a long period of time'.

**STACEY MUNRO** (right) has recently been appointed as a Membership and Grants Administrator covering Karen's maternity leave. Stacey gained a BSc in Biological Sciences from Robert Gordon University in Aberdeen and, after graduating, worked as a Research Assistant at the Macaulay Land Use Research Institute in Aberdeen. She completed her PhD in 2009, researching DNA repair at the University of St Andrews. Interests out of work include swimming, running and climbing ... anything outdoors and energetic.



L. Udakis

## STAFF

Congratulations to **JANE WESTWELL** who has been awarded a distinction in her Postgraduate Diploma in Applied Management from the University of Reading. Jane spent a challenging 2 years finely balancing the demands of family, work and study and says, 'It was a fantastic way to expand my knowledge of different aspects of business management. The applied nature of the course meant that all my learning has had relevance to our day-to-day activities at Marlborough House. I am very grateful to the SGM, and particularly to Ron Fraser, for supporting my efforts'. Jane was delighted to celebrate her graduation with her husband and two daughters who showed great patience while Mum was hidden away studying and writing assignments.

We are delighted that **KAREN MCGREGOR** and her partner James have announced the arrival of their second daughter Rachel Jennette Abbott on Wednesday 5 January 2011. Mum and baby are well and at home trying to catch up on their sleep!



A. McCartney



K. McGregor



L. Udakis

# PEOPLE

THE LATEST ON SOCIETY ACTIVITIES



## SGM PRIZE MEDAL LECTURE

**PROFESSOR SIR DAVID HOPWOOD** is the recipient of the SGM Medal, awarded annually to a microbiologist whose work has led to a far-reaching impact beyond microbiology. He will deliver his talk, *Streptomyces genomics: new routes to antibiotic discovery*, on Monday 11 April at the Spring Conference, Harrogate International Centre.

David studied botany at the University of Cambridge, with a particular interest in genetics. When he graduated in 1954, it was suggested that the streptomycetes, often thought to be intermediate between bacteria and fungi, would make an interesting subject for genetic analysis. During his doctoral studies at Cambridge, he discovered and harnessed natural gene exchange to make the first chromosome map of a streptomycete. With Audrey Glauert, he showed that the streptomycetes are true bacteria in their cellular organization and that their resemblance to fungi must have arisen independently. Nevertheless, the streptomycetes revealed many genetic novelties compared with other bacteria. More than 50 years later, after posts as Assistant Lecturer at Cambridge, Lecturer in Glasgow, and finally head of the Genetics Department at the John Innes Centre and Professor at the University of East Anglia, Norwich (now Emeritus), he is still interested in the same microbe – *Streptomyces coelicolor* – as on day one of his PhD studies! However, much water has flowed under the bridge in the meantime. Through the efforts of

many scientists, this organism became the genetic model for the actinomycetes, with versatile *in vivo* and *in vitro* genetics. David's interest in antibiotics

developed largely by accident, spurred on by studying the genetics of actinorhodin, the blue polyketide antibiotic pigment that gives *S. coelicolor* its name. After the complete gene cluster was cloned, segments of it were used to produce the first hybrid antibiotics by inter-species cloning. This was a catalyst for the development, again through a widespread effort, of the field of 'combinatorial biosynthesis of unnatural natural products'. Later, he coordinated the project to sequence the large linear chromosome of *S. coelicolor*. The *S. coelicolor* genome and those of other actinomycetes currently under study reveal a huge metabolic potential waiting to be unlocked. The lecture will touch on some of the special features of *Streptomyces* genetics, including a unique chromosome structure and mechanism of DNA transfer between strains, and will then focus on current efforts to 'wake up' the many 'sleeping' gene clusters for potentially valuable antibiotics, sorely needed in these days of increasing antibiotic resistance in dangerous pathogens.



# PRIZES

## Fleming Lecture

**DR PETER CHEREPANOV** (Imperial College London) will deliver his lecture, entitled *Structural biology of retroviral DNA integration* on Tuesday 12 April at the Society's Spring Conference at the Harrogate International Centre. The Fleming Lecture is awarded for outstanding research by a microbiologist in the early stages of their career. Peter writes:

I wanted to be a scientist for as long as I can remember. It probably had something to do with a popular Soviet-era chemistry magazine we subscribed to, more specifically the *Young Chemist* section in it. Experiments recommended

there would make a modern Safety Officer want to murder someone. Unsurprisingly, my experimentation at home abruptly ended when my parents discovered a significant stash of rocket fuel I had concocted and kept on our balcony.

Years later, while a student in the Novosibirsk State University in Siberia, USSR, I won a scholarship to go to West Germany as an exchange student. My experience with HIV and retroviruses started at the University of Leuven in Belgium, where I undertook a PhD and my first postdoctoral tenure with Drs Erik De Clercq and Zeger Debyser. Ever since, my work has focussed on retroviral DNA integration and the ways of inhibiting it. After almost 8 years in Leuven, I joined the laboratory of Dr Alan Engelman at Harvard Medical School. Through our collaborations within Harvard I was introduced to structural biology. I joined Imperial College London as a Senior Lecturer in 2005. In my group, we study the structural aspects of retroviral DNA integration, the mechanism of HIV resistance to integrase inhibitors and cellular factors involved in retrovirus replication.



L. Atherton

## EARLY-CAREER MEMBERS HAVE THEIR SAY...

Last autumn, Associate Members were invited to participate in a survey exploring their opinions of existing and potential SGM activities and membership benefits. Thanks are due to those members who took the time to plough through the detailed online survey and have provided us with some useful data that will guide us in the future.

## ...SGM ACTS

The survey suggested that career development workshops at SGM Conferences are still a popular option for early-career delegates, but they have been running at an unpopular time for the past 2 years. We have taken on board the responses and at the Spring Conference in Harrogate we will be organizing a pre-conference networking workshop and supper on Sunday evening. Additionally, a session devoted to the ever-important topic of how to get your research published will run at a more convenient time on Wednesday lunchtime.

## Colworth Prize Lecture

**PROFESSOR GEORGE SALMOND** (University of Cambridge) will deliver his prize lecture, entitled *Bacterial sociology: quorum sensing, virulence, antibiotics and survival*, on Wednesday 13 April 2011 at the Society's Spring Conference at the Harrogate International Centre. The Colworth Prize Lecture is awarded for an outstanding contribution in any area of applied microbiology.

George studied Microbiology at University of Strathclyde, gained a PhD on phage-host interactions at University of Warwick, then did postdoctoral research in Edinburgh on the genetics of *E. coli* cell division. He was a lecturer in Microbiology at Kent before returning to Warwick for 13 years as Lecturer, Senior Lecturer and



Professor. Since 1996, he has been Professor of Molecular Microbiology in the Biochemistry Department at Cambridge. He is a Professorial Fellow of Wolfson College. George has made important contributions to diverse microbiological areas, including bacterial cell division, methanotroph molecular biology, molecular phytopathogenesis, quorum sensing in Gram-negative bacteria, secondary metabolite production and regulation

(including carbapenem antibiotics and bioactive prodiginines), protein secretion systems, bacteriophage exploitation, and the nature of phage abortive infection systems with toxin-antitoxin functionality.

He has held many governance and advisory posts, including Member of the Scottish Science Advisory Council, Governor of the John Innes Centre and the Scottish Crop Research Institute, International Secretary and Council Member of the SGM, Member of FEMS Council, Royal Society Science Unions Committee Member, and Member of the Pathogen Sequencing Advisory Group of the Wellcome Trust Sanger Institute. He also worked at Celgene Corporation, New Jersey, and was on the Scientific Advisory Board of NSC Technologies, Illinois. He is President of the British Society for Plant Pathology.



**MARLBOROUGH HOUSE BUSINESS**

Council was provided with an update on the search for the replacement of SGM's incumbent Chief Executive, **DR RON FRASER**, who will retire in the summer of 2011. The process is moving ahead smoothly, facilitated by the engagement of recruitment consultants Perrett Laver.

Ron Fraser informed Council that the Marlborough House staff complement was back to full strength with the recent appointment of **DR KAREN MCGREGOR** as Membership Services and Grants Administrator in August.

Other items of note included the replacement of the main computer server.

This is required to run the new Contact Relationship Management (CRM) system, which will cover meetings, membership, journal sales, education and outreach activities. The system will be implemented over a 6–9 month period and will integrate with the SGM website, which will be updated in parallel. The new systems will enhance communication and interaction with members and others.

**PRESIDENT'S BUSINESS**

**PROFESSOR HILARY LAPPIN-SCOTT** welcomed two new elected members of Council: **PROFESSOR NIGEL BROWN** (University of Edinburgh) and **PROFESSOR JOHN SINCLAIR** (University of Cambridge). She then outlined plans for forthcoming strategic reviews. These will cover the SGM journals and publications business, the Spring and Autumn Conference structures and finances, and further engagement of SGM with government and policy-makers.

On the last point, SGM organized a Microbiology Awareness Campaign event at the House of Lords on

SGM had been invited to nominate individuals to serve on the next Research Excellence Framework (REF) sub-panels. Council was advised that 12 such nominations had been made, covering five sub-panels.

Following discussion to promote interaction of SGM with other professional microbiology societies, both national and international, it was agreed the President should host an annual dinner for invited guests, either at the Spring Conference, or as a stand-alone event.

**SGM PRIZES**

Council agreed on the recipients of the Fred Griffith Review Lecture, the Colworth Prize Lecture, the Fleming Lecture and the Peter Wildy Prize for Microbiology Education. Recipients will be announced in due course and will present their lectures at either the Spring or Autumn 2011 Conferences.

**SGM FINANCES**

The Treasurer, **PROFESSOR COLIN HARWOOD**, reported that the SGM's finances had maintained a healthy position and had weathered the recent financial turmoil. Spending on grants and education remained high. However, uptake of international grants to support microbiology-led initiatives in developing countries had been low. Council therefore agreed allocation of up to US\$12,000 for 2 years to support travel to international conferences by meritorious female microbiologists and their mentors funded by the African Women Scientists Working in Agricultural R&D (AWARD) fellowships. The AWARD programme is funded by the Bill and Melinda Gates Foundation but does not fund travel.

3 November hosted by Lord Soulsby of Swaffham Prior. The theme was *Microbes and Climate Change*. An article about the event can be found on p. 54 of this issue. Professor Lappin-Scott congratulated **DARIEL BURDASS** and her team on the success of the event. Discussion centred on how best to maintain the profile of microbiology with this audience.

**NOVEMBER COUNCIL MEETING HIGHLIGHTS**

Council also agreed that successful applicants should receive 1 year's free SGM membership.

Much of SGM's income derives from its journal publication business. *JSEM* is the journal of record for the identification of novel bacterial species. The impact on this of the anticipated rapid rise in novel species identification through next generation sequencing needs to be explored. Council therefore approved an allocation of funds to support Professor Harwood's suggestion of a by-invitation meeting of experts in bacterial taxonomy to explore this issue.

In other taxonomy news, Council agreed to continue support of the International Committee on the Taxonomy of Viruses (ICTV) for the next 3 years at £1,000 per year.

**SGM MEETINGS**

**DR EVELYN DOYLE**, Deputy Scientific Meetings Officer, standing in for Scientific Meetings Officer **PROFESSOR CHRIS HEWITT**, outlined the major forthcoming meetings. They include the April 2011 Conference in Harrogate, with the theme of *Intracellular life*, and the September 2011 Conference at the University of York. The March 2012 Conference will be held in Dublin, during that city's year as European City of Science.

**EDUCATION ACTIVITIES**

**PROFESSOR JOANNA VERRAN**, Education and Public Affairs Officer, reviewed recent and planned outreach events organized by SGM. In 2011, the Society will organize activities at the Manchester and Cheltenham Science Festivals and *Big Bang*.

The increase in schools membership to 756 was again warmly welcomed, up 50 on the same time last year.

**PUBLICATIONS**

**PROFESSOR HOWARD JENKINSON** presented the minutes from the recent Publications Committee meeting. One highlight included the increase of the impact factor of *JGV* to 3.26, taking it to second place in the general virology category. Council approved the request from **PROFESSOR RICHARD ELLIOTT**, *JGV* Editor-in-Chief, to appoint a Reviews Editor to solicit review articles and explore other innovations, for example compiling feature issues, hot topic articles and opinion pieces.

The next Council will be held in February 2011.

**DAVID BLACKBOURN**, GENERAL SECRETARY

**Nominations for Elected Members of SGM Council**

**DR KIM HARDIE** and **DR PAUL HOSKISSON** retire from Council in September 2011. Under the new Articles of Association adopted at the AGM on 9 September 2008, there is one vacancy to fill. Nominations must be proposed and seconded by Ordinary Members of the Society and should indicate the main area of microbiological interest of the nominee. Nominees must have been an Ordinary Member of the Society for at least 2 years and must indicate their willingness to be nominated in writing. Nominations should be sent to the SGM General Secretary, **PROFESSOR DAVID BLACKBOURN** ([d.j.blackbourn@bham.ac.uk](mailto:d.j.blackbourn@bham.ac.uk)) or c/o SGM Headquarters, to arrive no later than **29 APRIL 2011**. If the number of nominations exceeds the number of vacancies, an election will be held.



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SGM has a wide range of grant schemes to support microbiology. See [www.sgm.ac.uk](http://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](mailto:grants@sgm.ac.uk)).

Check out the current schemes to ensure that you don't miss any deadlines.

# GRANTS

## HEATLEY-PAYNE AWARD

Congratulations are due to winner of the SGM winner of this award, **DANIEL TROMANS** of University of East Anglia and the John Innes Centre. He will carry out a short research visit to the National Cancer Institute, Frederick, Maryland in May 2011. Following this, Daniel will travel to New Orleans to present his work at the ASM General Meeting. **DR ALEX DICKSON**, the US-based recipient of the Heatley-Payne Award, will be joining us in Harrogate to present her research and will also carry out a short research visit at the University of Glasgow, hosted by Dr Sheila Graham.

This scheme is offered jointly with the ASM. It supports the reciprocal exchange of one postgraduate student member to present their research at the other Society's main conference and a visit to a laboratory in that country. The award has been developed to strengthen the bonds between SGM and ASM. It is designed to benefit early-career microbiologists in the partner countries by giving them the opportunity to present their work overseas and experience the best of microbiology in the exchange country. Full details of this scheme, and the Hayes-Burnet Award, are available on the SGM website. Anyone interested in applying for a 2012 award should look out for the announcement and deadline in *Microbiology Today*.

## Travel & meetings

### POSTGRADUATE STUDENT CONFERENCE GRANTS

All Postgraduate Student Associate Members are eligible to apply for a grant to support their attendance at one SGM meeting each year. Grants contribute towards travel, registration and accommodation expenses. The student need not be presenting their research, so it is an ideal introduction to scientific meetings at little or no cost to themselves or their supervisor's budget. Applicants must be Postgraduate Student Associate Members resident and registered for a PhD in an EU country.

Closing date for Harrogate: **8 April 2011**.

### PRESIDENT'S FUND FOR RESEARCH VISITS

Up to £3,000 is available to support early-career microbiologists who are planning a short research visit to another laboratory (minimum visit 4 weeks, maximum visit 3 months).

## Medical microbiology support grants

### ELECTIVE GRANTS

Funding for medical/dental/veterinary students to work on microbiological projects in their elective periods.

The closing dates for applications in 2011 are **18 March** and **23 September**.

### TRAINEE SUPPORT GRANTS

Funding for SGM members carrying out small lab-based microbiology projects during either foundation or specialty postgraduate medical training. Up to £3,000 is available towards the consumables costs of a project.

The closing dates for applications in 2011 are **18 March** and **23 September**.

Closing dates for applications: **18 March** and **23 September 2011**.

### RETIRED MEMBER GRANTS

Cover accommodation and the Society Dinner at one SGM meeting a year.

Closing date for Harrogate: **8 April 2011**.

### SCIENTIFIC MEETINGS TRAVEL GRANTS

Support for early-career microbiologists wishing to present work at a scientific meeting in the UK or overseas. Graduate research assistants and lecturers (within 3 years of first appointment in both cases), postdoctoral researchers (within 3 years of first appointment) and postgraduate students are eligible to apply. Retrospective applications are not considered.

### REGIONAL MEETING GRANTS

Contribution of up to £2,000 towards the costs of running a regional microbiology meeting.

### TECHNICIAN MEETING GRANTS

All Associate Members who are technicians are eligible to apply for a grant to support their attendance at one SGM conference each year. Applicants need not be presenting work at the meeting. Some microbiology technicians who are not members of SGM may also apply for a grant to attend a Society conference.

Closing date for Harrogate: **8 April 2011**.

## Education & development

### NATIONAL

#### EDUCATION DEVELOPMENT FUND

Small grants to members for developments likely to lead to an improvement in the teaching of any aspect of microbiology relevant to secondary or tertiary education in the UK. Up to £1,000 is also available to support public engagement activities.

#### GRADSCHOOL GRANTS

Postgraduate Student members who are not eligible for a free place on a Vitae ([www.vitae.ac.uk](http://www.vitae.ac.uk)) personal development course (National GRADSschool) may now apply for a grant from SGM to cover full course fees. Retrospective applications are not considered.

Small grants to cover the travel and other expenses of up to two speakers on microbiological topics in annual departmental seminar programmes.

#### SEMINAR SPEAKERS FUND

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

#### STUDENT SOCIETY SPONSORED LECTURES

The Fund exists to provide training courses, publications and other help to microbiologists in developing countries.

### INTERNATIONAL

#### INTERNATIONAL DEVELOPMENT FUND

Closing dates for applications: **18 March** and **23 September 2011**.

**THE WATANABE BOOK FUND**

Members who are permanently resident in a developing country may apply for funding to acquire microbiology books for their libraries. These annual awards are available as a result of a generous donation from Professor T. Watanabe of Japan.

In 2010, an award was made to **DR TIM CUSHNIE**, Faculty of Science, Mahasarakham University, Thailand.

Applications for 2011 are invited.

Closing date for applications: **23 September 2011**.

## DIVISIONAL COMMITTEE ELECTIONS 2011

Under the new system for planning SGM's scientific meetings (described in the November 2007 issue of *Microbiology Today*, p. 146), members of Divisional Committees serve for 3 or 4 years. Replacements are now required for Members of the Committees due to retire in September 2011. There are two routes: the Divisional Committees themselves may nominate candidates; and Ordinary Members of the Society may make nominations. For the Virology, Eukaryotic Microbiology and Prokaryotic Microbiology Divisions, nominations must be in the cross-cutting theme in which the vacancy arises. The Irish and Education Divisions do not have cross-cutting themes. All nominees must be Members of the Society. Nominations are now invited for the following vacancies:

Division:	Virology	Eukaryotic Microbiology	Prokaryotic Microbiology
Cross-cutting theme:			
Microbial diversity & evolution	No vacancies	1 vacancy	1 vacancy
Fundamental microbiology	2 vacancies	3 vacancies	2 vacancies
Translational & applied microbiology	2 vacancies	1 vacancy	1 vacancy
Infectious disease	No vacancies	1 vacancy	2 vacancies
Division:	Education	Irish	
	2 vacancies	1 vacancy	

All nominations proposed by Ordinary Members of the Society must be seconded by another Ordinary Member, and must include a statement that the candidate is willing to stand, and which Division and, where appropriate, cross-cutting theme the nomination is for. A nomination form is available on the Society website at [www.sgm.ac.uk/meetings/divisions.cfm](http://www.sgm.ac.uk/meetings/divisions.cfm). Where the number of nominations from the Divisional Committees and Ordinary Members exceeds the number of vacancies, elections will be held.

Nominations should be sent to the Chief Executive, Dr Ron Fraser, SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG ([r.fraser@sgm.ac.uk](mailto:r.fraser@sgm.ac.uk)), to arrive no later than **18 April 2011**. A list of current members of Divisional Committees is available on the Society website at [www.sgm.ac.uk/meetings/divisions.cfm](http://www.sgm.ac.uk/meetings/divisions.cfm)

# ELECTIONS





Mycorrhizae. Eye of Science / Science Photo Library

## Bad news travels fast through mycorrhizae

Plants sharing a mycorrhizal network can exchange defence signals to help them ward off invading pathogens, according to a new study by scientists in China. They showed that when one plant in a network became infected with a pathogenic fungus, other plants in the network were less likely to become infected – and if they did, symptoms were milder. Around 80% of plants are colonized by fungi, with which they form symbiotic relationships. The fungal threads, called mycorrhizae, take in water and minerals from the soil in return for nutrition. The networks that they form allow plants to share these resources to protect themselves from drought. While using plant-to-plant communication to increase defence levels is not a new concept, studies have so far focussed on signalling through air-borne molecules. The discovery of a new role for mycorrhizal networks has prompted the researchers to describe mycorrhizae as 'the internet of plant communities'.

*PLoS One* doi:10.1371/journal.pone.0013324

Ageing. Coneyl Jay / Science Photo Library



## Youthful yeast

Yeast is fast becoming an ally in our quest to stay looking young. Biotechnology firm Retrotope in California have been experimenting with yeast to find a way to reduce oxidative damage of cell membranes, which typically occurs with ageing. PUFAs (polyunsaturated fatty acids) are vital to the structure and function of cell membranes, but are vulnerable to attack by free radicals that causes oxidative stress. The researchers proposed that PUFAs containing deuterium – or 'heavy hydrogen' – would be less susceptible to free radical attack, as deuterium forms stronger bonds. By feeding yeast essential PUFAs containing deuterium, scientists

showed that the cells were up to 150 times more resistant to oxidative stress compared to cells treated with hydrogen-containing fatty acids. The team of scientists is hoping to apply this technique to other cells, including those that are affected by oxidative stress in certain neurological diseases.

*Free Radical Biology and Medicine*  
doi:10.1016/j.freeradbiomed.2010.10.690

Circuit board. iStockphoto / Thinkstock



## Miniature microbial computers

Scientists have discovered how to build 'logic gates' into bacteria which could allow genetic engineers to turn cells into miniature computers. The researchers at the University of California – San Francisco constructed simple logic gates out of genes and inserted them into separate strains of *Escherichia coli*. The gates controlled the release of a chemical signalling molecule, allowing the cells to be connected in a cellular circuit. Synthetic biologist Dr Christopher Voigt, who is leading the project, said that the goal is to be able to programme cells using a formal language such as is used to write computer code. It is thought that this will enable cells to be programmed for a variety of purposes, including the production of pharmaceuticals, materials and industrial chemicals.

*Nature* doi:10.1038/nature09565

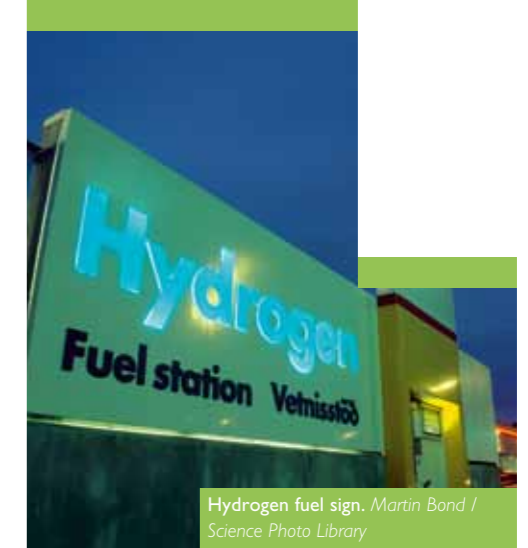
## 'It's not you, it's my gut microbes'

The bacteria that live in our guts could be influencing us more than we think – by helping determine the type of partner we choose. Researchers at Tel Aviv University have shown that symbiotic bacteria inside fruit flies can affect their choice of mate. The scientists argue that the process of natural selection is not just based on the individual living organism but on a larger unit called a 'holobiont' that includes symbiotic partners such as micro-organisms. Previous studies showed that fly populations that were divided and fed different diets preferred mates with the same nutritional background once the population was brought back together. The Tel Aviv team repeated this experiment with the addition of an antibiotic and found that specific mating preferences were eliminated. Analysis of pheromone levels showed differences between the two fly populations that disappeared after antibiotic administration. The researchers speculate that bacteria were driving this change in pheromones. *Lactobacillus plantarum* is thought to be the species responsible for the diet-related mating preferences. When this strain was reintroduced into antibiotic-treated flies, preferential mating behaviour resumed.

*PNAS* doi:10.1073/pnas.1009906107

## Bees help banish mouth ulcers

Bees may soon be taking the sting out of mouth ulcers, say scientists at the University of Bradford. The sticky mixture of resin and wax called propolis which is produced by honey bees to seal their hives, has long been known for its antimicrobial healing properties. However, its use in medicinal products has been limited due to its insolubility in water and its strong, unpleasant smell. Now researchers at the University of Bradford have managed to purify propolis in a



Hydrogen fuel sign. Martin Bond / Science Photo Library

## Multi-tasking microbe offers clean energy hope

A rare strain of cyanobacteria that can produce hydrogen as well as carrying out photosynthesis may be a good source of clean energy. Microbes that generate hydrogen normally require a zero oxygen environment, which makes the process very costly to scale-up. However, *Cyanothece* 51142 is able to photosynthesize during the day (producing oxygen) and fix nitrogen by night – generating hydrogen as a by-product. The two processes are regulated by an internal biological clock that is set by changing light levels. Scientists at Washington University in St Louis, Missouri, have discovered that the regular cycling between photosynthesis and nitrogen fixation continues even in constant daylight. What's more, the team has shown that hydrogen production is boosted in continuous light. The amount of hydrogen generated – 150  $\mu\text{mol}$  per mg chlorophyll per hour – is the most ever recorded in natural cyanobacteria under normal atmospheric conditions.

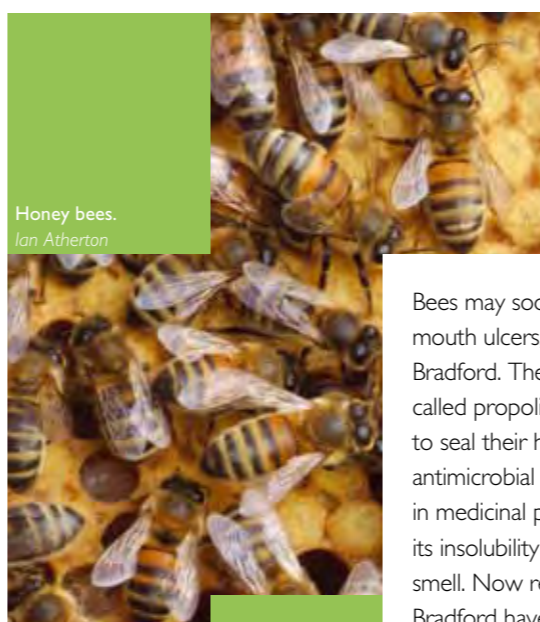
*Nature Communications* doi:10.1038/ncomms1139

way that retains its antimicrobial properties, eliminates its off-putting smell and makes it dissolve in water. From this, they have developed a new mouth ulcer gel. As the purified propolis retains some of its natural stickiness, it is able to adhere well to the skin membrane, which is a major barrier to the effectiveness of mouth gels. The scientists are confident that there is a big market for propolis-based products as propolis is antimicrobial, a strong antioxidant, non-allergenic and can boost immune function.

University of Bradford – [www.brad.ac.uk/mediacentre/press-releases/Title\\_34711\\_en.php](http://www.brad.ac.uk/mediacentre/press-releases/Title_34711_en.php)



Gut microbes. Hemera / Thinkstock



Honey bees. Ian Atherton





## OTHER EVENTS

**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](http://www2.kenes.com/fems2011/Pages/Home.aspx)

**Federation of Infection Societies Conference 2011**  
16–18 November 2011  
Manchester Central Convention Complex  
[www.fis2011.co.uk](http://www.fis2011.co.uk)

**IUMS 2011 Congresses**  
Sapporo, Japan, 6–16 September 2011  
[www.congre.co.jp/iums2011/sapporo](http://www.congre.co.jp/iums2011/sapporo)

## FUTURE

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  
([l.kulakov@qub.ac.uk](mailto:l.kulakov@qub.ac.uk))

Autumn 2011  
Institute of Technology Tallaght, Dublin  
1–2 September 2011  
**Microbial pathogenesis: the key to better therapies**  
Organizer: Dr Siobahn McClean  
([siobahn.mcclean@itt.dublin.ie](mailto:siobahn.mcclean@itt.dublin.ie))

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



Karen Rowlett

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Suggestions for topics for future symposia are always welcome.

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Science Photo Library

SPRING CONFERENCE 2011  
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## Virology Workshops

Pathogenesis | Replication & gene expression | Structural virology | Cell-to-cell transmission | Vaccines & antivirals

## Programme Preview

A booklet containing details of the scientific programme and summaries of each session is enclosed with this issue of *Microbiology Today*. Further information, including poster titles, will be published on the SGM website as it becomes available.

## Prize Lectures

**SGM Prize Medal** Sir David Hopwood FRS  
**Fleming Lecture** Peter Cherepanov  
**Colworth Prize** George Salmond

Approved for CPD by the Royal College of Pathologists and the Institute of Biomedical Science – up to 25 points available.

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Registration couldn't be easier: either register directly online at [www.sgmharrogate2011.org.uk](http://www.sgmharrogate2011.org.uk) or complete (and return) the downloadable PDF.

Earlybird registration rate deadline: **4 March 2011**.

## Venue

Harrogate is a beautiful spa town located to the south-east of the Yorkshire Dales. Located just 25 minutes from Leeds and Bradford International Airport, the town is well connected to the rest of the UK by road and rail.

## Accommodation

All accommodation can be booked through Reservation Highway (via the conference website), who have secured a range of rooms at discounted rates throughout Harrogate to suit all budgets. All participants are strongly advised to book early as Harrogate is hosting several other events during this time.

## Personal Development Workshops

**Networking workshop & supper for early-career delegates – April 10**

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The essential guide to the 'whys' and 'hows' of getting your research published.

## CPD

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Manchester Central





A 17th century plague doctor in protective costume. NYPL / Science Source / Science Photo Library

PETRA OYSTON



# The power of hindsight: lessons from plague

Since ancient times, *Yersinia pestis* has wreaked havoc on the human population. But what can the transmission and evolution of this unusual pathogen teach us about how we might prepare for future emergent pathogens?

**PLAGUE**, caused by *Yersinia pestis*, is a World Health Organization (WHO) notifiable disease. Every year several thousand cases are reported, although this is probably an under-representation of the actual number of cases. Infection circulates in sylvatic foci, i.e. in rodent populations where it is transmitted between animals by the bite of infected fleas. Humans are accidental hosts, with most infections

occurring following the bite of an infected flea when in close contact with infected rodents. Body lice have also been shown to be vectors for plague. Infection can also result after handling and skinning of dead animals, usually in hunters. Domestic animals such as cats are also susceptible to plague, and can transmit the disease to humans during close contact. The distribution of human plague

coincides with the distribution of sylvatic plague.

Three clinical forms of plague occur in humans: bubonic, septicemic and pneumonic plague.

Bubonic plague is the classical form of the disease. Patients present with fever, chills, headache and a painful bubo. Bubonic plague arises as a result of a bite from an infected arthropod vector or by contamination



Father Petrus Martinus and his brothers nursing and burying plague victims in 1564. Jean-Loup Charmet / Science Photo Library

P. Petrus Martinus S. J. ein Spanier/trittet nit ohne grossen Widerstand seiner Natur in die Gesellschaft ein / und lebet darinn mit grösster Zufriedenheit und Ruhe. Stirbet endlich mit ohngefehr 30. anderen





Coloured scanning electron micrograph of the rat flea *Xenopsylla cheopis* clinging to the fur of a rat. The rat flea plays a major role in the spread of *Yersinia pestis*. Dr Tony Brain / Science Photo Library

of an open skin lesion. Patients develop a significant bacteraemia. Untreated, the case fatality rate is 40–60%, but where therapy is used this can be reduced to around 14%.

When *Y. pestis* infection with bacteraemia occurs without the development of lymphadenopathy, this is primary septicaemic plague which occurs in about 10–25% of cases. Due to difficulties in diagnosis and thus delays in appropriate antibiotic therapy, and the acute nature of the disease, mortality rates are higher than for bubonic plague. Untreated, septicaemic plague is almost always fatal.

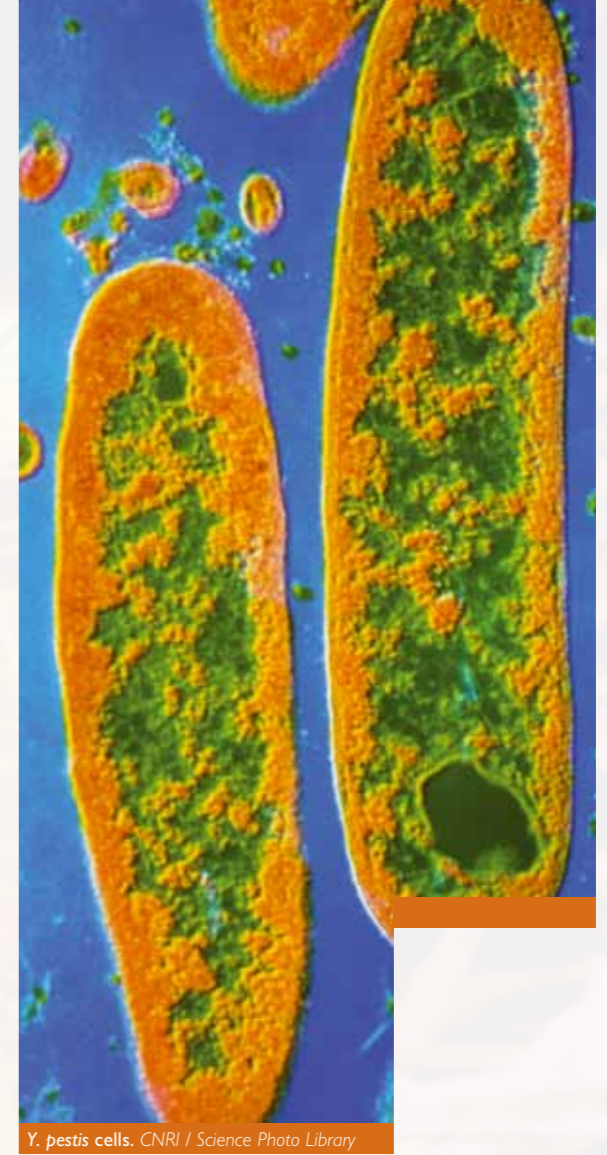
Primary pneumonic plague arises as a result of inhalation of plague bacilli in infectious aerosols, such as would be produced when there are pneumonia complications in bubonic plague. This is the form of the disease that would be most likely if *Y. pestis* were to be used as a biological weapon. Pneumonic plague is invariably fatal unless antibiotic therapy commences within 24 hours of exposure. Patients

with pneumonic plague pose a significant hazard to close contacts.

### HISTORY

Cycles of plague have swept across the world in three documented pandemics. The first pandemic is known as the Justinian Plague (AD 541–544). The plague arrived in Egypt from Ethiopia, and then spread through North Africa, Europe, Arabia, and Central and Southern Asia. Epidemics spread in 8- to 12-year cycles, often repeatedly infecting the same areas. The second pandemic started in the 14th century, spreading from the steppes of Central Asia westward along trade routes. The plague then spread northwards in Europe, killing an estimated 40% of the population and earning it the name the Black Death. The third pandemic appears to have originated in the Chinese province of Yunnan in 1855, spreading due to war and troop movements to the southern coast, reaching Hong Kong in 1894. Maritime routes allowed the global spread of infection, and the Americas were infected for the first time; stable enzootic foci were established on every major continent with the exception of Australia. The vestigial remnants of the third pandemic persist to the present day, although the numbers of cases are much reduced, largely due to effective public health measures and the introduction of antibiotics. Three biovars are recognized, all of which are virulent, and it has been suggested that they are linked to the three pandemics. Nowadays, biovar

*“Y. pestis appears to have passed through an evolutionary bottleneck and, in its relatively isolated niche, is unable to restore the array of pseudogenes it now possesses.”*



*Y. pestis* cells. CNRI / Science Photo Library

Antiqua strains are isolated in Africa, and may be descended from the bacteria that caused the first pandemic; Medievalis strains are isolated in Central Asia and may be related to the bacteria of the second pandemic; Orientalis strains are widespread and appear to be the cause of the current pandemic.

Complete genome sequences are available for a range of strains of *Y. pestis* from the various biovars. The genome of plague consists of the chromosome and three plasmids, and it is the plasmids that carry many of the known virulence factors of *Y. pestis*. The genome possesses a large number of insertion sequences and appears to have undergone frequent intragenomic recombination. Indeed, recombination appears to be an on-going process, even in the present day. Whilst the organism has acquired additional genes during its adaptation from enteric pathogen to systemic, arthropod-vectorated pathogen, the bacterium also has many pseudogenes in pathways that are no longer essential. *Y. pestis* appears to have passed through an evolutionary bottleneck and, in its relatively isolated niche, is unable to restore the array of pseudogenes it now possesses. It is thus probably in an evolutionary dead-end.

### TRANSMISSION

Arthropod-vectorated transmission depends upon a significant septicaemia developing in the infected mammal. Plague can survive and replicate in the digestive tract of the flea to form large, dark masses visible by microscopy. The

proventriculus of the flea is lined with spines of cuticle and, as the bacterial aggregates accumulate among the spines, the passage of blood into the midgut of the flea is restricted, resulting in the flea becoming blocked. As the blocked flea attempts to feed, fragments of the bacterial aggregates are regurgitated into the bite site and the mammalian host is infected; this transmission method has been shown to be quite inefficient. Additionally, high levels of septicaemia in the infected mammal are required to allow the infection of a subsequent flea vector; this may explain the emergence of highly virulent strains in order to ensure transmission. Thus, when we consider the emergence of plague, we must consider its adaptation to both mammalian and arthropod hosts, its inability to survive well in the environment which has led to vectorated transmission, and the limitations of the vector which have necessitated such a massive septicaemia to ensure transmission, which ultimately kills the host.



As mentioned above, in addition to being an arthropod-vector disease, plague can also be transmitted in aerosols to produce pneumonic plague. In the modern world concerned about biological threats, it is anticipated that plague as a weapon would be released as an aerosol to produce pneumonic plague casualties, who in turn would pose a significant risk to contacts. This is in contrast to many other biothreat agents, such as tularaemia or melioidosis, where inhalation results in a pneumonia, but there is no human-to-human aerosol transmission. No doubt this ability to spread efficiently in aerosols contributed to the pandemic spread of plague. However, we know very little about the behaviour of *Y. pestis* in aerosols, nor why it is so efficiently transmitted when other pathogens are not.

#### LESSONS TO BE LEARNT

So what can we learn from following the emergence of plague? *Y. pestis* is a clonal derivative of *Yersinia pseudotuberculosis* which emerged relatively recently in evolutionary terms, between 15,000 and 20,000 years ago. The changes required to go from the enteric pathogenic lifestyle of *Y. pseudotuberculosis* to the complex lifestyle described above are many and varied. It would be hard to predict that this is how the organism would evolve, either in terms of biology or in terms of genetics. So perhaps it is not possible to predict the next new disease to emerge based on a knowledge of current organisms. There are, however, lessons to be learnt from the pandemics and ongoing outbreaks.

First, the risk of an outbreak appears to be increased during times of upheaval, such as war or natural disaster. Take, as an illustration, the 1994 outbreak in Surat, India. The outbreak is believed to have started with an individual who had contracted bubonic plague almost certainly

as a consequence of a flea bite. About this time there had been some major earth tremors in this part of India that had resulted in some people abandoning their homes. Grain and other foodstuffs which were left in these abandoned houses were a source of food for rodents, whose numbers increased rapidly. From the index case of bubonic plague reported in the August, secondary pneumonic cases were reported, and events unfolded which had consequences worldwide. By late September, more than 300 suspected cases of pneumonic plague were reported in the Surat area and 36 deaths. People fled the area. Countries closed their borders or introduced quarantine measures for arrivals. Therefore, it is imperative that outbreaks of serious disease in often disrupted and remote places are detected in a timely manner.

Second, there is also a need for an understanding of the natural host of a zoonotic pathogen and its mode of transmission. For example, it is known that rats living

*“Perhaps it is not possible to predict the next new disease to emerge based on a knowledge of current organisms.”*

close to people in endemic areas pose a plague risk to humans. However, culling rat populations is not the straightforward solution it may appear. Insecticides must be used to kill fleas if rodent hosts are to be killed and this must be done before rodenticides are employed. Such approaches are labour-intensive and not particularly effective on a large scale in enzootic areas. More effective are measures to eliminate rodent habitats and a reduction in the appeal of residential areas to rodents, combined with treatment of domestic pets for fleas. However, during an outbreak of plague in humans it is important to control populations of both fleas and rodents. If the rodent population has been reduced in number by plague, fleas will seek alternative hosts, including man, resulting in spread of bubonic plague. Thus flea populations must be reduced before control of rodent reservoirs can then be undertaken.

The Indian outbreak also illustrates a third lesson: international travel means disease travels around the world much more quickly these days. Plague took hundreds of years to colonize the world prior to air travel, travelling with people on foot, horseback or on ships, down trade routes or following armies across land or sea. However, the incubation period of bubonic plague is 2–6 days, and 1–3 days for pneumonic plague: inter-

continental travel is easily achievable in these time-frames nowadays. Also, the non-specific febrile symptoms of pneumonic plague make diagnosis difficult, so cases may not be detected before they pose a risk to contacts. Thus, in the USA, travellers who arrived from India were given a plague alert notice and told to notify the public health authorities if they developed a febrile illness within 7 days of arriving in the USA. Those who arrived suffering from a febrile illness were examined and were quarantined if plague was suspected. However, these measures were only introduced in light of a known outbreak. In the event of an unidentified outbreak, or with a disease with a longer incubation period, such border security would fail. Diagnostic tests, including pre-symptomatic diagnostics, may go some way towards addressing these deficits, but would need to be developed to detect infection with a newly emerged novel pathogen.

Finally, the often repeated story of antibiotic therapy, and the dangers of relying on such compounds in the face of increasing levels of resistance, is unfortunately also coming true for plague, as for so many infections. In endemic areas, multi-resistant strains of *Y. pestis* have been isolated. These resistant strains are rare, but for other pathogens such as *Burkholderia*, inherent resistance is the norm. Therefore, not only is there a need to determine the resistance profile of emerging pathogens and identify suitable therapeutics, but there is also a need for novel medical countermeasures to increase the available options. Vaccines offer solid protection against specific pathogens, but for a completely new licensed vaccine to be developed against an emerging pathogen, the timescales are measured in decades.

So, based on our knowledge of pandemic plague, we can identify areas of concern that we need to address for any other emerging diseases. However, there is one great unanswered question for plague: were the pandemics driven

by human activity facilitating spread or were pandemic strains different to endemic strains? There has been some unsupported speculation that the Black Death was not caused by *Y. pestis*, despite plague genes being amplified repeatedly from skeletons in plague pits dating from that period. This discussion has been stimulated by discrepancies between modern plague and the historical reports from the period. For a summary of the evidence against that speculation, the reader is directed towards a letter by Michel Drancourt and Didier Raoult (see below). However, they point out that ‘*analogic reasoning based on observations of current infectious diseases cannot be applied to the medieval Black Death*’. This may be because, as they suggest, the primary transmission was body lice during the medieval period, or it may be that the organism was genetically subtly different. It is known that the *Y. pestis* genome is highly plastic, undergoing constant rearrangements, which could have been the driver for this. However, because of the degraded nature of DNA from medieval burials, it would currently be impossible to undertake complete genome sequencing to establish this. It has been suggested that plague victims buried in Finland would be preserved in the permafrost and this may represent a potential source of better quality DNA for sequencing to answer that question. Perhaps, then, we would know whether a hypervirulent pandemic plague strain could break out unexpectedly, or whether the current endemic situation is the norm.

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#### FURTHER READING

Drancourt, M. & Raoult, D. (2010). Body lice, *Yersinia pestis* Orientalis, and Black Death – in response (letter). *Emerg Infect Dis* [www.cdc.gov/EID/content/16/10/1649.htm](http://www.cdc.gov/EID/content/16/10/1649.htm) (doi:10.3201/eid1610.100946)

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Leg of a patient with septicaemic plague. CDC



Swollen lymph node, or bubo, under the arm of a patient with bubonic plague. CDC / Margaret Parsons, Dr Karl F. Meyer





Measles virus in brain tissue. P. Duprex

PAUL DUPREX  
ELKE MÜHLBERGER

#### EMERGING AND RE-EMERGING

viruses will be a continuing threat to human health because of their amazing potential to adapt to their current hosts, to switch to new hosts and to evolve strategies to escape antiviral measures. Moreover, global climate changes and destruction of habitats, in combination with extensive travel activity, may promote the spread of currently unknown pathogens. This threat comes not only from naturally occurring infections, but may also arise from bio-terrorism attacks involving deliberate release. Some emerging viruses, such as filoviruses, have attracted substantial scientific and popular attention despite the fact that less than 3,000 cases have been described since the first isolation of Marburg virus more than 40 years ago. Nevertheless, the deadly appearance of these viruses, with fatality rates of up to 90%, would most likely cause panic and social disruption in the case of an outbreak.

#### SEEING THE VIRUS THROUGH A DISEASE IN THE HOST

*Contagion vivum fluidum* quite literally means 'infectious living liquid'. Around the early 1900s, science and medicine only indirectly witnessed the effects of these 'liquids' in their hosts, leading to the inextricable linkage of virology and pathology. Rabies virus infection was visualized through the resulting acute encephalitis, while



# The virus is 'dead'.

# Long 'live' the virus!



Background. MMR vaccine. Saturn Stills / Science Photo Library

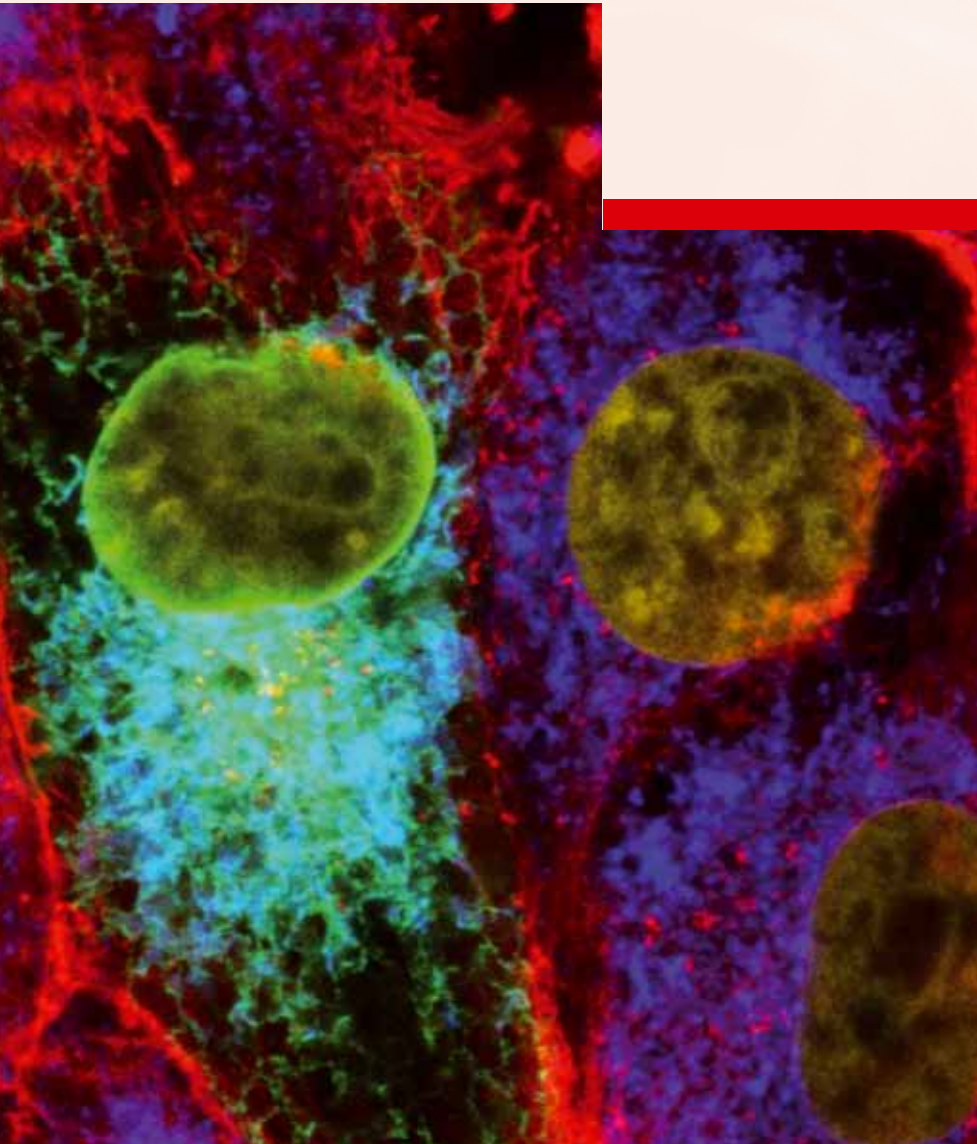
How do we face up to the global challenge of emerging viral infections? With a solid grasp of the historical perspective and armed with the latest genomic toolkit, we can now evaluate the relative merits of eradication, vaccination and chemotherapy.

foot-and-mouth disease virus, the first animal virus to be filtered, manifested itself through blisters and weight loss in cloven-hoofed animals. Not until electron microscopy opened our eyes to crown-like coronas, star-like astros and sand-like arenas did the veil start to lift on these agents of disease which, for millennia, wreaked untold suffering across the globe.

Virology's tenet of 'isolate, attenuate and vaccinate' was central in the 1950s. With the advent of *in vitro* cell culture, phenotypes were extended in this *in vitro* world and cytopathic effects such as cell-to-cell fusion were invaluable in describing what viruses did outside of an animal. This opened the door for pioneers such as Merck's Maurice Hilleman, a vaccinologist of huge stature, to develop measles, chickenpox and hepatitis A and B vaccines, to name but a few. Indeed, like Henrietta Lacks of HeLa cell fame, his daughter Jeryl Lynn remains immortalized in the JL mumps vaccine strain. In those halcyon days, empirical, 'blind' passage of human pathogens through non-human cell lines or eggs at non-optimal temperatures was the modus operandi. However, the term 'empirical' far from diminishes these achievements and, when these accomplishments are weighed against the aspirations of 21st century rational vaccinologists, the scales are tipped well in favour of the pragmatists. It would be difficult to perform either a comprehensive or even credible analysis of the tremendous impact these empirically derived, virus vaccines have had on human health. Not only do they represent some of the most complex biopharmaceuticals yet produced, they also provide an example of how inherently unstable, oftentimes live-attenuated, products can be manufactured safely, formulated effectively and distributed globally. The scene was now set for humankind to wage war on some of our greatest foes.

#### CELEBRATING THE 'DEATH' OF A VIRUS

A zenith in vaccinology occurred in 1979 when a group of scientists, and thereafter the World Health Organization



Mumps virus protein (small hydrophobic protein, turquoise) in the endoplasmic reticulum of a cultured cell. This protein may be involved in determining how effectively the virus can infect people. P. Duprex / Wellcome Images



*“It is only by understanding virology’s history that one can fully appreciate the plethora of emerging viruses yet to be discovered and the possibilities the past 30 years of molecular virology afford.”*

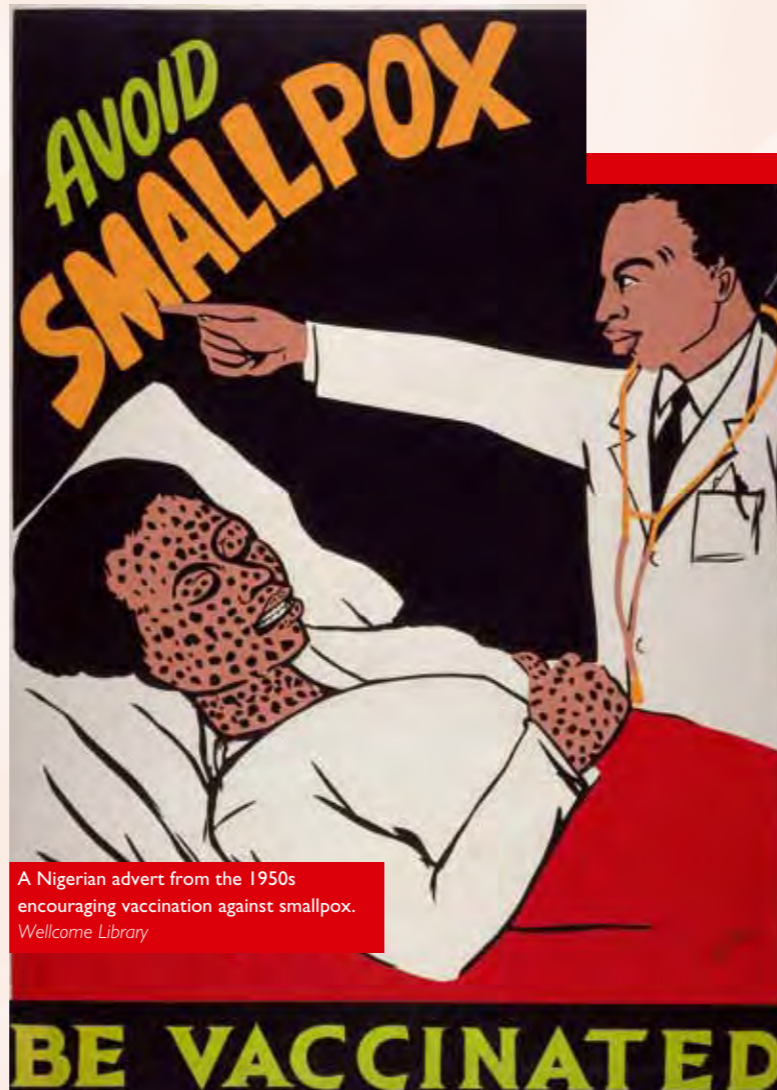
desirable attribute in any such endeavour) and HIV-1 was only waiting in the wings. These might be considered as the discipline’s golden days. The scene was set to draw up a hit list and for timelines to be drawn for the eradication of more of our greatest foes, and we set our sights on rinderpest, polio and measles viruses.

**BRINGING VIRUSES TO ‘LIFE’ IN A MOLECULAR WORLD**

If the 1960s and 1970s were focussed on pathogenesis and empirical attenuation, then the 1980s saw the field shift in the direction of the genome, and virology and pathology diverged somewhat. For quite some time these molecular virologists were lonely genomists, simply due to logarithmic advantage; the US\$1,000 sequence of a 1,000,000,000 base pair genome was a long way off! At that time, the only tractable genomes were those of the viruses, both in terms of sequencing and manipulation. David Baltimore’s seminal publication in 1981, which showed that poliovirus could be recovered ‘simply’ by introducing a complementary copy of the complete 7,414 nucleotide genome into a permissive cell, lit the touch paper for a new generation of virologists. Reverse genetics was born and, as we will see below, in the hands of the adept molecular virologist, viruses could, and would, ‘live’ forever.

Probably some of the most important work centred on

(WHO), formally certified that smallpox had been eradicated. In this individual case a reasonable cost/benefit analysis suggests annual savings are over US\$1 billion. This would never have been possible without the unprecedented collaboration between governments, donors and industry, underpinned by health professionals in the field and local communities. As with many such seminal achievements this triggered much discussion, mostly focussed on whether or not laboratory samples of the virus should be formally destroyed. In 1986, WHO recommended destruction by 1993, although the date subsequently drifted to 1999; the policy was finally reversed in 2002. In May 2010, a bronze sculpture was unveiled outside WHO HQ commemorating the 30th anniversary of this seminal achievement, the first virus to be wiped from the face of the earth through the use of a highly efficacious vaccine. It has often been discussed whether smallpox was unique; thankfully, this is not the case. The virus only infected humans, there was no animal reservoir, the vaccine provided life-long immunity (a highly



A Nigerian advert from the 1950s encouraging vaccination against smallpox. Wellcome Library

mapping the molecular basis of attenuation, which was far from trivial. Again the polio virologists led the way, and a single nucleotide in the untranslated region of the genome was shown to be a key determinant of the attenuation phenotype. Viruses have since been manipulated in many ways, including the replacement and addition of extra genes, and genomes have been both split and rearranged in previously unimaginable ways. It is fair to say that virology and pathology diverged significantly during the genomic era. Promoters, atomic structures and site-directed mutations of single amino acid codons in open reading frames were the order of the day. Today, Fred Sanger’s first 5,386 nucleotide genome of the single-stranded bacteriophage  $\phi$ X174 could be synthesized in its entirety *de novo* for US\$2,000. The scene was set for the vaccine tool kit to be expanded and rational vaccinology was born.

**DEALING WITH EMERGING PATHOGENS AND EVOLVING CHALLENGES IN GLOBAL HEALTH**

Why are these historical perspectives important in an article which aims to discuss the global challenges of emerging viral infections? It is only by understanding virology’s history that one can fully appreciate the plethora of emerging viruses yet to be discovered and the possibilities that the past 30 years of molecular virology afford. What has become apparent over the last number of years is that there are many unidentified viruses present and circulating in unidentified animal reservoirs. Although, based on our molecular, pathological and epidemiological expertise, we would like to believe that we have the skills and

resources to predict when and where novel agents will arise, that is far from the case. There are many other articles which focus on the virus hunters who boldly go where many virologists fear to tread. They deal with emerging and re-emerging viral pathogens and grasp the nettles of Ebola, Lassa and Rift Valley fever viruses in Africa, Nipah virus in South East Asia, Chikungunya in India, Crimean Congo hemorrhagic fever virus in Turkey and Pakistan, New World arenaviruses in South America, H1N1 (2009) ‘swine flu’ across the globe, Dengue virus in Central and South America, Indonesia and Cape Verde, and severe acute respiratory syndrome virus in China. Emerging viruses are not restricted to the developing world and stark lessons and significant economic costs are associated with the to-this-day-unexplained introduction of West Nile virus into the USA. This crystallizes why these emerging pathogens matter from both public health and economic standpoints.

Not all re-emerging viruses need to be associated with significant



A nurse administering an oral vaccine against polio to an infant in India. S. Nagendra / Science Photo Library



mortality to provide cause for concern. The circulation of mumps virus in the USA and the UK in university-age students might be an early warning of waning immunity; indeed mumps has recently been designated a re-emerging virus. Could Jeryl Lynn's longevity be in threat as viruses do what they do best – evolve? All of these examples highlight the critical role microbiology plays in global health and show that it is vital to maintain a cohort of international virologists who are well-versed in pathogenesis, molecular epidemiology and zoonotic infections. International surveillance, research and coordinated cooperation in battling emerging and re-emerging viruses are essential. Investment in state-of-the-art facilities, such as The National Emerging Infectious Diseases Laboratories (NEIDL), is essential. Part of a national network of secure facilities, researchers in these laboratories are dedicated to the development of diagnostics, vaccines and therapeutics to combat emerging and re-emerging infectious diseases in biosafety levels 2, 3 and 4, the latter being the highest level of containment possible.

### ERADICATION, DESTRUCTION AND RE-CREATION USING SYNTHETIC BIOLOGY

As molecular virologists who recognize the utility of returning to the pathological roots of virology, our laboratories see pathogenesis and attenuation as two sides of one coin. We believe that it is essential to understand primary pathogenesis and dissect the early cells targeted by both vaccines and wild-type viruses. In order to do this, we contend that we need to take one step back and develop reverse genetics systems for viruses which have never been passaged *in*

*vitro*. For too long we have relied on laboratory-adapted viruses, which use non-pathologically relevant receptors and exhibit spurious cytopathic effects, thus leading us in the wrong direction. Even though we have trained ourselves to become proficient molecular biologists, our skills pale into insignificance compared to the greatest genetic engineer, nature itself. This is where caution is required as it is evident that biological agents evolve to fill a niche and, even though eradication is a noble goal, it might not be without concomitant risks, especially if vaccination was discontinued.

In 2011, depending on your faith or lack of faith in humanity, discussions pertaining to the destruction of the remaining vials of smallpox might be considered somewhat quaint or even passé. There is no question that although eradication is a noble goal, there is a fundamental distinction between eradication from general circulation and elimination from controlled environments such as high-containment biosafety level 4 facilities. In the halcyon days of vaccinology, the idea of synthesizing the complete 180,102 base pair genome of smallpox virus lay firmly in the realms of science fiction. However, times have changed and the work of Wimmer and colleagues fired a shot across the bows of the good ship 'Eradication' when a synthetic, full-length infectious clone of poliovirus was assembled using oligonucleotides purchased using the internet. This proved that even if a virus was eradicated, it was possible for competent molecular virologists to generate the agent *de novo*. Interestingly, the existence of networks of individuals, for example those associated with DIYbio, extends the reach of molecular biology well beyond traditional research laboratories and

gives some regulatory bodies cause for concern. Poliovirus, although targeted for eradication, has proved recalcitrant and, in spite of major efforts employed by the global health community, the virus is still problematic, making discussion of the *de novo* generation of wild-type virus somewhat moot, at least for the time being. However, the eradication of rinderpest virus in 2010 proved that consigning smallpox to the history books was not an exception. With a genome of only 15,882 nucleotides and the availability of robust reverse genetics systems for negative-strand RNA viruses, the recreation of one of the most virulent animal pathogens known is far from impossible and the potential for such a virus to 're-emerge' from a molecular clone must be recognized. With this

in mind, it must be considered that eradication of a virus is a redundant concept which, in the modern world, should be consigned to the history books or, for want of a better term, eradicated.

### LONG 'LIVE' THE VIRUS

Where does this leave us in terms of the global challenges of virus infection? Are all the empirical advances of Hilleman lost and are the rational vaccinologists wasting their time trying to generate new vaccines to help eradicate agents which are very easy to regenerate? To use the old adage, 'forewarned is forearmed'. It is better that international funding agencies are developing and supporting a new generation of scientists who are driven to understand

the intricacies and interplay between pathogenesis and attenuation. Only by appreciating these interleaved aspects of key infectious diseases can we hope to be able to shift the historical paradigm of vaccinology from simple to targeted isolation and from empirical to rational attenuation and from non-specific to tissue-targeted vaccination. In addition, due to the huge developmental costs involved, vaccines are not really attractive candidates for most of the highly pathogenic, emerging viruses. Therefore, the development of antiviral therapeutics is a critically important part of being prepared to combat emerging and re-emerging viruses.

In many ways, virology has come full circle and virologists and pathologists are re-embracing their historical roots. More importantly, they must recognize the need to liaise with immunologists, cell biologists, pharmaceutical chemists and global decision-makers. In this multidisciplinary world, there are unrivalled opportunities and technologies which permit the dissection of the molecular basis of

attenuation and pathogenesis. In the UK, funders such as the Wellcome Trust and the Medical Research Council have never lost sight of the need to support fundamental virology, developmental vaccinology and animal models of disease, all of which are vital for successful translation of novel ideas into complex biopharmaceuticals. Moreover, the global reach of the Wellcome Trust is evident through its partnership with the Bill and Melinda Gates Foundation and together they vehemently believe in the success and utility of vaccines. Complementing this, and in many ways coming full circle to where we began, the opening of the Merck Wellcome Trust Hilleman Laboratories in India represents a ground-breaking partnership which aims to develop new vaccines in, and for, the developing world. What better illustration of how the current global changes in vaccine development are being addressed through international collaborations. Of course there are many challenges and complexities in a commercial world where intellectual prosperity is dispersed. However, a long overdue renaissance in vaccinology has commenced, and it is with anticipation and excitement that we wait to see progress in the next decade.

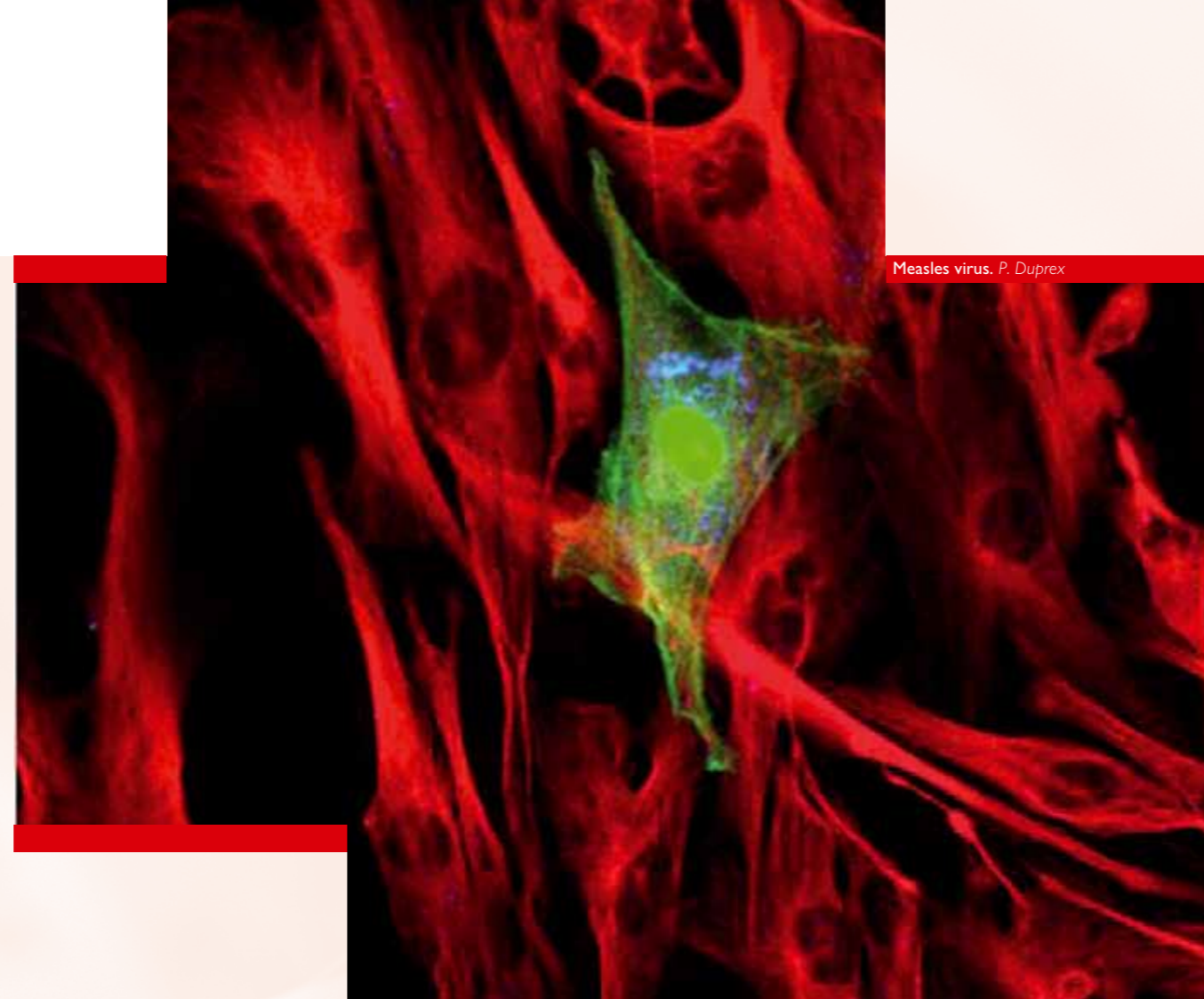
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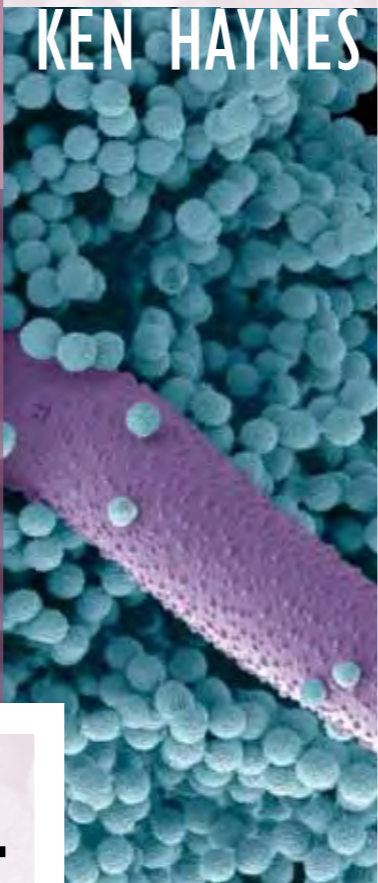
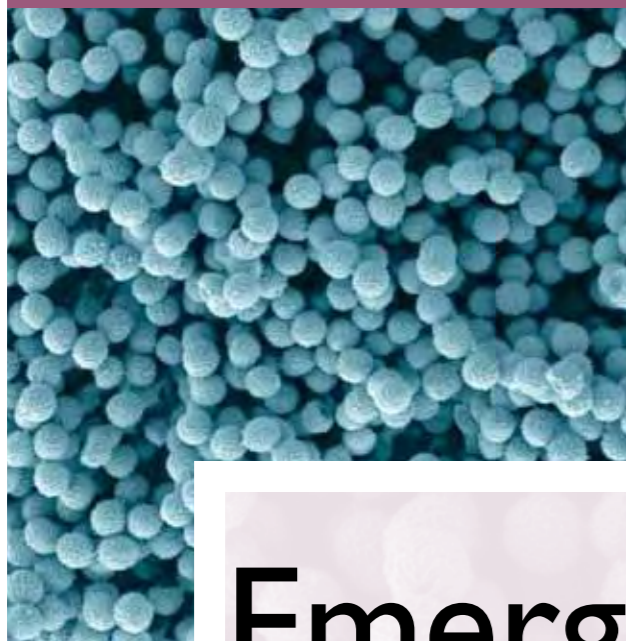
*“A long overdue renaissance in vaccinology has commenced, and it is with anticipation and excitement that we wait to see progress in the next decade.”*



Measles virus. P. Duprex



KEN HAYNES

Spores of *Aspergillus fumigatus*. Steve Gschmeissner / Science Photo Library

# Emerging fungal pathogens

As the number of immunocompromised individuals grows, fungal pathogens are becoming ever more important. How are functional genomics technologies helping to combat these less than well known eukaryotic adversaries?



Pseudohyphae and yeast-like cells of *Candida albicans*. David Scharf / Science Photo Library

**THE LATE 20TH** and early 21st centuries have seen the emergence (HIV), re-emergence (TB) and progression (malaria) of infectious disease around the world. The antibiotic age seemed to have rid us, the developed world at least, of the massive impact wrought by devastating infectious diseases. However, the war has not been won. Microbial pathogens have fought back, with extraordinary resourcefulness. Antibiotic resistance has given rise to populations of bacteria that are almost untreatable; vancomycin-resistant *Staphylococcus aureus* is a prime example. In addition, successful antibiotic therapies, combined paradoxically with advances in medical treatments, especially in the areas of transplantation and chemotherapy, have resulted in the emergence of a large group of immunocompromised patients that are now at serious risk of invasive, life-threatening disease from a group of fungi. These organisms are perhaps less well known than their bacterial and viral counterparts, but are nonetheless devastating for that. Although there are approximately 400 fungi that have been described as pathogens of humans, I will concentrate on members of the three genera *Aspergillus*, *Candida* and *Cryptococcus*.

These fungi are distant relatives from an evolutionary perspective. *Aspergillus fumigatus* is a filamentous ascomycete; *Candida albicans* is a di-(multi)morphic ascomycetous fungus; *Candida glabrata* is a hemiascomycetous yeast; and *Cryptococcus neoformans* is a dimorphic basidiomycete. Given this diversity, a number of questions arise. What attributes do they have that allow them to proliferate within the human host? Are these attributes shared? Can they be exploited for therapy/disease management? Is it likely that new pathogens will emerge? I will attempt to address these in turn.

## VIRULENCE ATTRIBUTES

Most studies on fungal attributes essential for disease have focussed on processes (e.g. filamentation, stress resistance) or structures (e.g. cell wall, capsule) that rationally seem important

for disease. In many instances, genes homologous to those already known to be involved in these processes in the model, non-pathogenic brewer's/baker's yeast *Saccharomyces cerevisiae* have been identified in the pathogen of choice, inactivated and the impact on virulence determined, usually via a small mammal model of infection. This direct approach has led to a great deal of understanding of the molecular basis of disease. For example, in *C. albicans* cell wall, glycosylation, phenotypic switching and adaptation to environmental stress have all been shown to be required for infection to be established and/or proceed. However, this is a biased view of disease in the sense that it relies on scientific intuition and previous knowledge. It also relies on the assumption that the annotated function of the *S. cerevisiae* gene will be conserved in the pathogen under study. This is not always the case, and, excitingly, there are now many examples of how evolutionarily conserved proteins have been functionally reassigned in pathogenic fungi, when compared to *S. cerevisiae*, which promote survival within the human host.

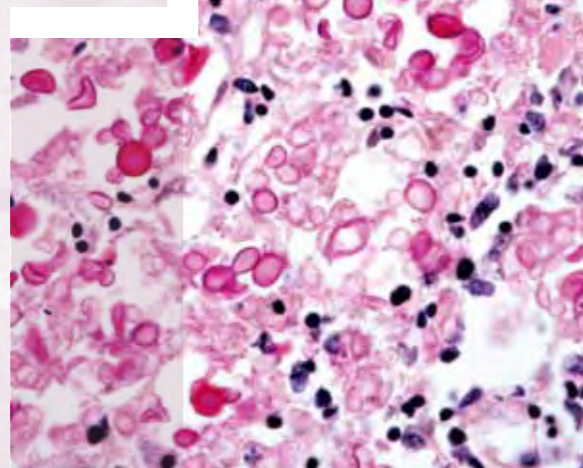
A less biased approach has also been adopted. This has come about with the advent of functional genomics technologies, which blossomed in model organisms but have their roots firmly in the pathogenic world. Signature-tagged mutagenesis (STM) was developed in *Salmonella typhimurium*, although initially the technology was aimed at *Aspergillus fumigatus*. This technique was the first example of an inactivated gene being uniquely tagged with a specific molecular barcode. This allowed the change in relative abundance of each barcode, and hence mutant, in a pool to be determined in response to a specific screen, e.g. passage through a model of infection, facilitating large-scale *in vivo* screening for the first time. In *C. neoformans*, STM was used to identify genes that, when deleted, resulted in reduced infectivity. Of those identified, ~80% encoded functions that were associated with previously known virulence attri-



butes. The remaining 20% of genes encoded novel virulence-associated proteins, including transcription factors, proteins involved in chromatin remodelling and, excitingly, a majority with no known function. When STM methodology was applied to *C. glabrata*, a surprising finding was made. Rather than attenuation, inactivation of the transcription factor Ace2 prompted a 200-fold increase in the ability to cause disease. This was echoed in the *C. neoformans* screen, where a total of 33 mutants with increased infective capacity were seen. Applying this technology to pathogens such as *C. albicans* is complicated by the fact that this species has a diploid genome. However, recently a set of homozygous, knock-out strains representing ~11% of the *C. albicans* genome were screened in a mouse model of infection. Stunningly, of over 100 strains with reduced infectivity *in vivo*, more than half exhibited normal morphological switching, suggesting that the connection between morphogenesis and infection is subtler than often stated. Indeed, these data strongly suggest that multiple attributes are required for establishment and progression of disease.

An alternative unbiased method to identify potential virulence attributes involves identifying those fungal genes specifically induced during the disease process. Unfortunately, the comparative load of fungi to host tissue, and hence the small amounts of pathogen mRNA present, represents a serious technical obstacle to *in vivo* expression profiling. However, applying a linear RNA amplification technique on *A. fumigatus* nucleic acid extracted directly from lungs, 12–14 hours post-infection, yielded sufficient material to perform microarray analysis. These experiments revealed that the host environment was stressful, at least compared to the 5-star health spa equivalent of complete media, and that, in infected tissue, *A. fumigatus* mounts a starvation response. Similar findings have also been made upon examining the *C. albicans* transcript profile during tissue invasion in mouse models of infection. Taken together, these analyses show that an unbiased approach can reveal novel and unexpected aspects of the disease process.

Such unbiased approaches are set to explode in the near future; the genome sequences of over 20 pathogenic fungi have now been reported and many more are in the pipeline. Many of these fungi are relatively intractable experimentally, but new approaches can be adopted to analyse them. DNA sequencing is becoming ever cheaper, and directly sequencing RNA populations *in vivo* is now technically possible, thereby facilitating the analysis of pathogen gene expression in the host at different stages of the infection process. In addition, it is now possible to contemplate the construction of global pathogen ORFeomes (each gene cloned in, e.g. Invitrogen's Gateway system), and hence facilitating functional analysis through



*Cryptococcus neoformans* in a lymph node. Dr Frederick Skvara, Visuals Unlimited / Science Photo Library

over-expression or localization, not only in the pathogen but also in heterologous hosts. These approaches will yield valuable information on host-pathogen interactions and also allow analysis of seemingly intractable organisms, an important consideration given the continued emergence of novel, previously unstudied pathogens.

One of the principle messages obtained from studies aimed at elucidating fungal virulence is that there appears to be a group of shared attributes that all fungi need to cause disease. Below, I have listed four that I believe to be important.

It almost goes without saying, and sometimes does, that the ability to grow and thrive at 37°C is absolutely essential for fungi to exploit human niches. Nutritional plasticity, or at least the ability to utilize many different carbon and nitrogen sources, and to scavenge limiting elements such as iron, is a second common theme in host survival. The cell wall is also crucial to the success of a fungal pathogen. This is hardly surprising as it is the first point of contact between the invading organisms and the host. However, it is not just the structural integrity of the wall that is important (which will be discussed later in the section on antifungals), but also its composition. In *C. albicans* and *C. glabrata*, changing the cell wall through removal of cell-wall-associated proteins, or their post-translational modification can have divergent effects, e.g. an attenuation or increase in the ability to cause disease. Finally, all successful pathogens need to be able to recognize and adapt to the new conditions encountered within the human host. For many pathogens, the host environment is different to its natural habitat, e.g. *A. fumigatus* is usually found in leaf litter, and species that are natural inhabitants of humans, e.g. *C. albicans*, often cause disease in sites that are distinct from their usual niche. Hence the host environment is likely to be stressful in terms of a number of environmental parameters, e.g. pH, osmolarity, and the presence of reactive oxygen and nitrogen species. Pathogenic fungi must be able to survive such environmental insults. Underpinning these common traits are orchestrated, integrated signalling and regulatory pathways, the components and wiring of which may vary

“There is a need to be vigilant and to expect the appearance of the unexpected.”

from species to species (this in itself is an active area of research), but have essentially evolved to solve the same problems: growth at 37°C, nutritional competency, cell-wall integrity and adaptation to the host environment. Without solving these problems, infection and subsequent disease progression would not take place.

### EXPLOITING VIRULENCE ATTRIBUTES

Can these attributes be exploited for the development of therapies and/or novel diagnostics? The short answer is yes. The fungal cell wall contains a number of polysaccharides that not only function to give it structural integrity, but also its amazing plasticity. These polysaccharides are synthesized by a group of glycosyltransferases that add additional sugar units to the growing polymer. One of these enzymes,  $\beta(1-3)$ -D-glucan synthase, is the target for the novel echinocandin class of antifungals. That said, and despite the success of echinocandins, many of the other attributes needed for fungal survival in the host, including other aspects of cell-wall biology, remain unexploited in terms of antifungal chemistry and/or diagnostics. One reason for this is undoubtedly technical, i.e. a lack of high-throughput functional assays. A second is that most large pharmaceutical companies do not have an antifungal discovery programme. However, this offers an opportunity for academic laboratories and Small and Medium Enterprises (SMEs) to fill the gap. To do this, much more research on

the molecular basis of disease, in a large number of pathogens, needs to be undertaken, and this requires funding. The MRC Infections and Immunity (IIB) panel currently funds grants that could be classified by microbial groups in the following ratios: virology 52%, bacteriology 28%, parasitology 19% and mycology 1%. To ensure a flow of new therapies and diagnostics for current and emerging fungal disease, this needs to change.

### WILL NOVEL PATHOGENS EMERGE?

There must be other species out there that share these attributes, and/or that are capable of growth in the expanding immunocompromised patient population; only a tiny fraction of the estimated one million fungal species have been scientifically described. If one looks at the recent literature, a group of fungi are starting to raise their heads as pathogens. These include, but are not limited to, species of filamentous fungi (e.g. *Acremonium* spp., *Alternaria* spp., *Bipolaris* spp., *Fusarium* spp., *Paecilomyces* spp., *Pseudoallescheria boydii* and *Scedosporium prolificans*) and yeast-like organisms (e.g. *Trichosporon* spp. and *Rhodotorula rubrum*). In addition there has been a shift in the incidence of candidiasis with previously rare species, e.g. *Candida krusei*, now causing significant levels of disease. This list is likely to develop both in terms of numbers and individually important species, especially in light of increases in the number and nature of immunosuppressed patients. Furthermore, the variation in sensitivity of these species to commonly used antifungals, and also the policy of antifungal use, is likely to impact on their incidence. There is thus a

need to be vigilant and to expect the appearance of the unexpected.

Fungi are among some of the most successful organisms on Earth. They have exploited a huge array of niches and it is testament to the immune defences of the human host that so few have evolved to be our natural pathogens. That said, the advances in medicine that have been so beneficial have ironically opened a niche, the immunocompromised patient, which these versatile and adaptable organisms can exploit. As Dr Ian Malcolm (Jeff Goldblum) said in *Jurassic Park* ‘life finds a way’. Expect more of them to pop up.

Thankfully, we now have tools and approaches that will allow us to analyse each species as it emerges. Furthermore, it is likely that these approaches will reveal both species-specific and, perhaps more tellingly, further common attributes that can be exploited in disease management.

### ACKNOWLEDGEMENTS

I would like to thank Elaine Bignell, Alan Brown, Stephen Mitchell and Jan Quinn for helpful comments. I owe all my colleagues, past and present, at Imperial College London a huge debt of gratitude for making the last 26 years such fun. Work from the Haynes lab described herein was supported by BBSRC.

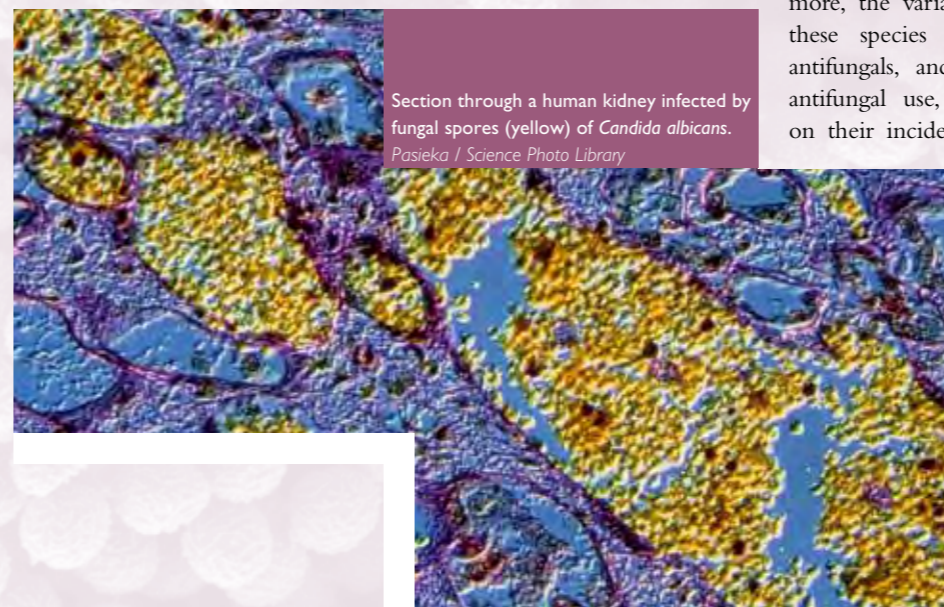
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Section through a human kidney infected by fungal spores (yellow) of *Candida albicans*. Pasiëka / Science Photo Library



Leishmaniasis has been recognized since ancient times and, with at least 50,000 deaths a year due to this parasitic infection, it is certainly of current importance. But is there any evidence to suggest that it can be considered as a re-emerging disease?

**LEISHMANIASIS** has been recognized for several hundred years, with descriptions of cutaneous lesions as early as the 7th century BC. However, it wasn't until early in the 20th century that Major William Leishman and Charles Donovan independently identified a parasite as the causative agent of 'kala-azar'. Writing in 1904, Leishman suggested that the identification of *Leishmania* would 'help us in clearing up the rest of the life history of the parasite, and put us on the track to what should be our ultimate goal – the prevention and, if possible, the stamping out of the disease'. Yet, despite over a hundred years of intensive research into understanding both this protozoan parasite and the host biology, cases of leishmaniasis in the 21st century are on the increase, with widespread drug resistance and no effective vaccine.

It is now known that there are two distinct forms of the disease – visceral leishmaniasis (or kala-azar) and cutaneous infection – and these are each associated with infection by specific species of *Leishmania*. Cutaneous leishmaniasis

often heals over time, leaving the patient disfigured and scarred, but it can recrudescence following treatment or spread to other areas, causing a diffuse cutaneous infection, particularly in immunocompromised individuals. A more severe muco-cutaneous form of infection is characterized by destructive ulceration of mucosal membranes and associated tissue. Visceral disease is by far the most severe form of leishmaniasis and is associated with infection of major organs, namely the spleen, liver and bone marrow. Patients generally present with symptoms of persistent infection and fever associated with chronic inflammation, and, if left untreated, the systemic disease is usually fatal.



Major William Leishman (1865–1926).  
Science Photo Library

OWAIN MILLINGTON



A macrophage engulfing a *Leishmania* parasite (green). Juergen Berger / Science Photo Library

# *Leishmania* as a re-emerging pathogen



Together, *Leishmania* infections are found in 88 different countries and account for an estimated 12 million infections. Each year, there are approximately 500,000 new cases of visceral leishmaniasis (causing over 50,000 deaths) and 1.5 million cutaneous infections, with the latter primarily seen in areas of Afghanistan, Brazil, Iran, Saudi Arabia and Sudan. Whilst these figures highlight the importance of the disease, this is almost certainly an under-representation of the number of infections due to a lack of reliable diagnoses, a protracted asymptomatic phase and the fact that reporting is only compulsory in 32 countries. Indeed, it is estimated that the real burden of disease could be as much as four to five times higher than is reported. It is therefore clear that leishmaniasis represents an important tropical disease, but can it really be considered as a re-emerging pathogen? There are several important factors that suggest that this may be the case:

#### MOBILIZATION OF PEOPLE

As described above, *Leishmania* parasites were first identified in soldiers as they spread throughout the British Empire. Unfortunately, very little has changed in over 100 years and many cases of leishmaniasis seen in hospitals in the 'developed world' are in military personnel infected in countries such as Iraq and Afghanistan. Thus, 522 US military personnel were treated for *Leishmania* infection between 2002 and early 2004, and returning troops are told not to donate blood for 12 months. One upside of this resurgence of infections seen in patients from such affluent nations is an increased focus on research and preventative measures, including development of pyrethroid-impregnated bednets with a much tighter weave than malaria nets (the sandfly vector is much smaller than the mosquito), as well as funding for research into the underlying biology of infection and development of new vaccine strategies.

Significantly, the migration of large numbers of people (either due to military action or associated with urbanization in developing countries)

also accounts for the re-emergence of *Leishmania*. Civil war in southern Sudan was associated with around 100,000 deaths attributed to visceral leishmaniasis among a population of only 280,000. More recently, one Afghan refugee settlement recently saw as many as one-third of its inhabitants develop leishmaniasis, thought to be associated with infected migrant carriers disseminating infection to the non-immune population. Additionally, massive urbanization, such as that seen in the Brazilian Amazon basin, can result in exposure of non-immune individuals to infection, with the potential for epidemic conditions. For example, as people moved from rural areas into large housing estates, infection rates doubled from 21,800 cases in 1998 to 40,000 just 4 years later in one area of Brazil. Thus, the movement of people into areas with active infection or migration of infected individuals into new areas provides the potential for epidemic spread of *Leishmania*.

#### ENVIRONMENTAL CHANGES

As natural transmission of *Leishmania* is through the bite of a sandfly, infections are obviously only seen in areas where the vector is found. In Europe, cases of leishmaniasis have been restricted predominantly to the southern regions of several Mediterranean countries, where the prevalence can be as high as 8 per 100,000 and seroprevalence in dogs can reach 50%. Until recently, it had been assumed that sandflies were not found in central Europe, and studies in Austria suggested that climatic conditions there differed substantially from those known to harbour sandflies. However, current reports suggest that an increase in temperature by just 1 °C would result in conditions suitable for sandflies in Austria and considerable expansion of other sandfly habitats across central Europe. Indeed, several reports have demonstrated the occurrence of sandflies in areas of Germany and Belgium. Clearly, this has important implications for the spread of *Leishmania*, and isolated cases of visceral and cutaneous leishmaniasis have recently been described in patients from Germany and from southern England, respectively.

Another important factor which may influence *Leishmania* transmission is the reservoir host population. The parasites are found in a diverse range of mammalian reservoir hosts, depending on the species of parasite, the geographical location and the local habitat. Therefore, changes to these intricate ecosystems can have implications for the zoonotic transmission of infection. One interesting example is the description of an expansion in the popu-

*“The three global influences on Leishmania transmission and disease burden suggest that we may need to think of this parasite as a re-emerging pathogen and prepare public health strategies for this.”*

The replacement of camels by off-road vehicles for desert transport may be inadvertently increasing the host reservoir for leishmaniasis. *Hemera / Thinkstock*



A cutaneous leishmaniasis lesion. The ulcer on the patient's leg has been coated in a traditional red remedy containing mercury. *A Crump, TDR, WHO / Science Photo Library*



lation of the reservoir hosts *Psammomys obesus* (fat sand rat) and *Meriones* spp. (gerbil), which may be associated with an increase in vegetation for which the camel is the only natural competitor. Unfortunately, the replacement of the camel with off-road vehicles may have inadvertently allowed these reservoir hosts to thrive, demonstrating the complexity of such ecosystems and the potential for them to impact on global health.

#### CO-INFECTION WITH HIV

With an estimated 33.4 million patients currently infected with HIV, one of the most alarming observations over recent years has been the emergence of co-infection with *Leishmania*. HIV/*Leishmania* co-infections were first described in the mid 1980s, particularly in southern Europe, and it is currently estimated that between 2 and 12% of all visceral leishmaniasis cases are co-infections (although in some areas this could be as high as 30%). As highlighted above, this may represent a distinct under-reporting, since the presence of *Leishmania* is rarely tested in HIV patients. Critically, HIV infection dramatically increases the risk of developing visceral leishmaniasis between 100- and 1000-fold. Conversely, *Leishmania* infection promotes HIV replication and expedites progression towards an AIDS-defining illness. Whilst the introduction of highly active antiretroviral therapy (HAART) to combat HIV in Europe reduced the burden of co-infection, there have been significant obstacles to applying this approach globally (e.g. cost of treatment). Also, anti-leishmanial drugs are less effective in HIV-infected patients, and relapses following treatment are much more likely. Thus, with the spread of HIV into areas of endemic *Leishmania* (e.g. India), there is a significant risk of co-infection dramatically increasing the burden of both diseases.

#### IN CONCLUSION

These three global influences on *Leishmania* transmission and disease burden suggest that we may need to think of this parasite as a re-emerging pathogen and prepare public health strategies for this. Current treatments are prohibitively expensive for much of the world population and the recent Cochrane review called for 'an international strategy to improve the quality and standardization of future trials for a better evidence-based strategic approach'. Future research must therefore focus on improving our understanding of the fundamental biology of the disease to allow us to develop new therapeutic approaches and vaccine strategies for this re-emerging parasitic disease.

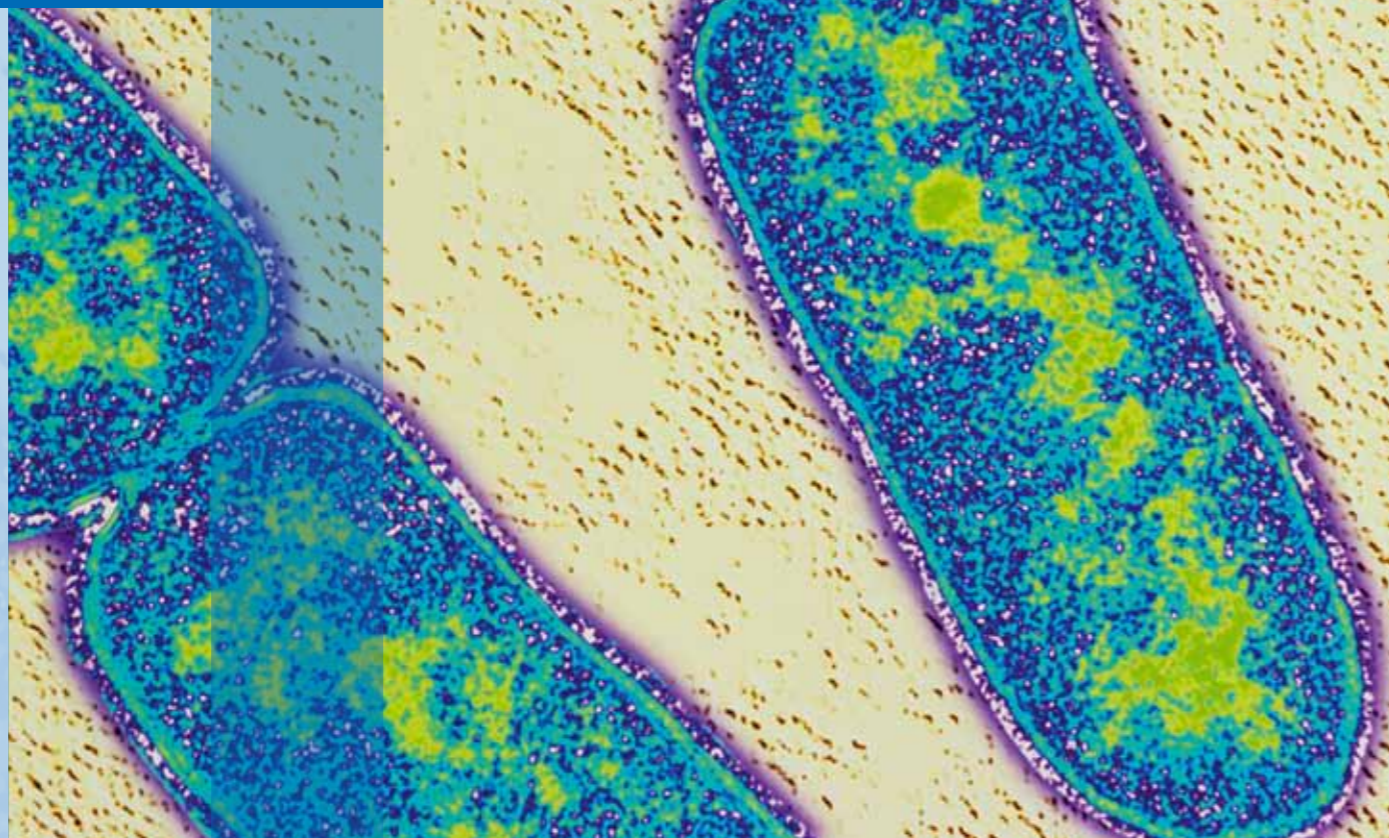
**OWAIN MILLINGTON**, Centre for Biophotonics, SIPBS Building, University of Strathclyde, Glasgow G4 0RE (email [owain.millington@strath.ac.uk](mailto:owain.millington@strath.ac.uk))

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*Mycobacterium tuberculosis* cells.  
Pasieka / Science Photo Library



# Tuberculosis: forgotten but not gone

STEPHEN GILLESPIE

UK scientists had an important role to play in the development of the first antibiotics for the treatment of tuberculosis in the mid-20th century. As we enter the second decade of the 21st century, the world is now confronted with the appearance of extremely drug-resistant strains. What are UK scientists doing this time to help combat this serious threat?

**TUBERCULOSIS** (TB) arises as a result of an infection by the bacillus *Mycobacterium tuberculosis*. Typically, it causes a chronic, progressive lung infection characterized by a cough and profound weight loss. It was this latter characteristic that gave tuberculosis its common name 'consumption', as those afflicted slowly wasted away.

The disease was first recognized and described as *phthisis* by Hippocrates in the 4th century BC, but it was not until the last decade of the 19th century that its cause was unequivocally determined when Robert Koch identified the *M. tuberculosis* bacillus in the specimens and tissues of patients, and was able to infect animals which developed a similar disease. Even though the cause was known, the only treatments available for the next 50 years were fresh air (the sanatorium), cod liver oil and artificially puncturing the lung. These treatments probably had little or no effect

on the final outcome of a disease that had a 50% 2-year mortality.

## THE ANTIBIOTIC ERA

It was not until the mid-1940s that specific antibiotic therapy became available when Selman Waksman and Albert Schatz extracted a substance named streptomycin from a *Streptomyces* bacterium isolated from the soil. Shortly after this, a number of other antibiotics with activity against *M. tuberculosis* were described (see Table 1).

The UK played an important role in developing effective treatment

regimens. When streptomycin was first available, there was not enough for all of the patients who needed it, so the Medical Research Council team who had been asked

Table 1. Some key events in the history of TB drug discovery

Date	Antibiotic
1945	Streptomycin
1949	<i>p</i> -Aminosalicylic acid
1952	Isoniazid
1954	Pyrazinamide
1955	Cycloserine
1962	Ethambutol
1963	Rifampicin

to investigate the new drug decided that it was fair and ethical to develop a randomized placebo control trial of the new treatment. This was the first trial of this type ever performed, and the importance of its results made it the standard way of testing new drugs throughout the world. What the study revealed was that the patients receiving streptomycin fared much better initially, but at the end of 5 years the same number of patients had died. This was because the organisms infecting the streptomycin-treated patients had developed resistance. Fortunately, other drugs had been developed and could be combined with streptomycin; of these the most important was isoniazid. As new drugs became available, the Medical Research Council tuberculosis unit and their counterparts in the US Public Health Service trialled new agents in various combinations, incorporating rifampicin



in the 1960s and, in the 1970s, rediscovering the value of pyrazinamide, which had previously been rejected due to toxicity. Each of the new regimens was shorter so that, by the time that the regimen that remains the international standard was finalized, treatment duration had reduced from 2 years to 6 months.

In most European and North American countries, the combination of effective treatment, rising living standards and BCG vaccination resulted in the number of cases of tuberculosis falling to very low levels. In resource-poor countries, however, the number of cases did not fall in the same way. Also, for many countries in sub-Saharan Africa, the emergence of human immunodeficiency virus (HIV) was a catastrophe as the virus rendered the patients especially susceptible to TB. From the mid-1980s, the number of cases of TB increased rapidly across the continent.

### MULTIPLE DRUG RESISTANCE

Alongside HIV is another growing problem, that of multiple drug resistance. *M. tuberculosis* develops resistance to antibiotics through mutations in its chromosome, and such resistance can emerge very quickly. It is for this reason that we need to use multiple drug regimens as one protects the other against the risk of resistance. Thus, resistance usually arises as a result of healthcare professionals prescribing an inadequate regimen or the patient not taking all of their drugs correctly so that the bacterium is exposed to only one of the agents. Under such circumstances, resistance can arise quickly and, one by one, the organism can become resistant to each of the drugs in the regimen.

Multiple drug-resistant TB (MDR-TB) is defined as resistance to rifampicin and isoniazid because of the critical

*“Although there is much to do, the essential components of effective collaborative groups are now in place and there is now hope that, if we persevere, we will be able to defeat this disease.”*

importance of these two drugs in bringing about a cure. The remaining drugs do not have the same ability to kill the pathogen and treatment may need to be prolonged. Consequently, the outcome of MDR-TB is much

worse than that of susceptible disease. In some countries with ineffective tuberculosis control programmes, MDR-TB can make up a quarter of all new cases.

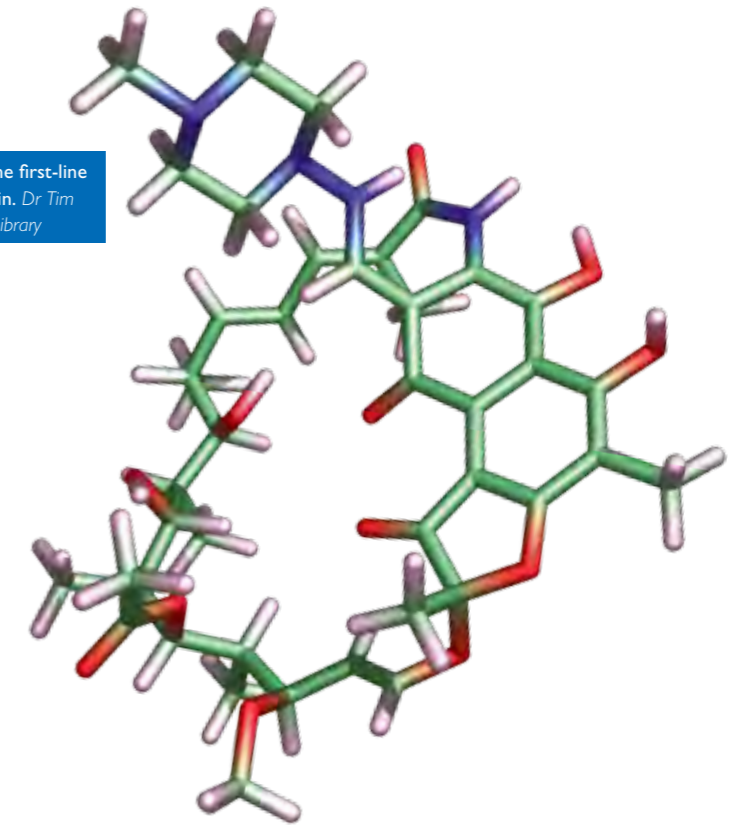
More recently, we have seen outbreaks of infection with *M. tuberculosis* that is resistant not only to rifampicin and isoniazid, but also to second-line antibiotics such as kanamycin and members of the quinolone family. These strains are usually called extensively drug-resistant TB (XDR-TB).

### NEW TOOLS, NEW CHALLENGES

Thus, the growing burden of TB worldwide and the increasing risk of infection by drug-resistant strains make it imperative that we develop new tools to defeat TB. Among these tools, new drugs are crucial. At the turn of the millennium, a new approach was forged and a public-private partnership, the Global Alliance for TB Drug Development, was founded. The aim of this group is to develop new treatment regimens that are significantly shorter than the current 6 months. The first stage of this process was the formation of a consortium to evaluate moxifloxacin, a fluoroquinolone antibiotic, in a regimen capable of treating TB in only 4 months. Some pharmaceutical companies have been encouraged to re-enter TB drug discovery and development. Together with pharmaceutical companies, the Global Alliance's aim is to develop a regimen that will take only 2 months to treat TB.

As was the case at the start of the antibiotic era for TB, UK scientists are playing an important role in developing and testing new drugs. The REMoxTB consortium is led by researchers from the University of St Andrews, University College London and the MRC Clinical Trials Unit. The trial is funded by the Global Alliance for TB Drug Development, the European Developing Country Clinical Trials Partnership (EDCTP) and the Medical Research Council. It is taking place in more than 18 sites

Molecular model of the first-line TB antibiotic rifampicin. Dr Tim Evans / Science Photo Library



throughout the world and aims to recruit 1,900 patients before the end of 2011. As the first regulatory trial, it is setting the standard for future studies.

More importantly, a wider group of UK scientists have come together to form TB DUK – Tuberculosis Drug Discovery UK ([www.tbd-uk.org.uk](http://www.tbd-uk.org.uk)). This group, which includes medicinal chemists, microbiologists and clinicians, aims to strengthen the UK research portfolio in discovery and development of new anti-TB drugs. It has already had considerable success in generating new research funding and is currently investigating several promising new compounds.

TB continues to be a major threat to human health, and we declared victory prematurely. Although there is much to do, the essential components of effective collaborative groups are now in place and there is now hope that, if we persevere, we will be able to defeat this disease. UK scientists are at the forefront of efforts to conquer the threat.

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A 19th century advert claiming a cure for consumption. Wellcome Medical Image Library



This article is based on the SGM Peter Wildy Prize Lecture, delivered by Sue Assinder at the SGM Autumn 2010 Conference in Nottingham on 8 September.

# How the mushroom got its spots and other stories

*Amanita muscaria* in the Tatra Mountains, Poland. S. Assinder



**THE IDEA THAT SCIENTISTS** have a responsibility to communicate their work to the public is not new. However, talking to the public about science used to be an activity conducted only by a few committed eccentrics under the radar of the academic 'day job'. It is now a legitimate enterprise supported by a framework of national and international science centres and festivals, and is endorsed by funding bodies and university management alike. The relationship between scientists and the public has also changed. When I first became involved around 15 years ago, science communication was working to a 'deficit model' of increasing public understanding of science by imparting information. Today, the focus is on engaging the public as active participants through dialogue and discussion.

The current movement in science communication can be attributed to the publication in 1985 of a report entitled *The Public Understanding of Science*, which detailed the outcomes of a Royal Society working group chaired by Sir Walter Bodmer. The 'Bodmer Report' told Britain's scientists that they had a duty to communicate with the public. This legitimized popularizing science and also helped to mobilize the resources to move things forward (although it did have the effect of saddling science communication for several years with the unfortunate acronym 'PUS'). A key step was the establishment of the organization 'COPUS' (Committee on the Public Understanding of Science) by the Royal Society, the British Association for the Advancement of Science and the Royal Institution. The aim of COPUS was to interpret scientific advances and make them more accessible to non-scientists, and it awarded grants to scientists wishing to run events for public audiences. Following this lead, the UK research councils also began to establish their



own PUS grant schemes, many of them targeted at younger scientists. It was one such scheme set up by the Biotechnology and Biological Sciences Research Council (BBSRC) that proved to be a turning point in my career.

I was fortunate in 1995 to win the first BBSRC Science Communicator Award with a project aimed at producing a teaching resource pack about DNA. Until that point, my experience of science communication had been limited to extracting DNA from onions for school children in the frenetic environment of National Science Week university open days. Although fun to do, I was frustrated by the limitations of the 'hit and run' interaction with the audience and saw the BBSRC competition as an opportunity to develop a more structured approach. I chose to target the pack at primary school teachers, mainly because I wanted to work with an audience for whom it had not yet become 'uncool' to be enthusiastic.

It is important to appreciate the context in which this project was set. Today, thanks to the 'CSI effect', DNA is part of everyday vocabulary, used frequently on TV and radio without feeling the need for any explanation. However, in 1995, few people outside of a lab had heard of DNA, and the seminal text from which the public was drawing its knowledge was *Jurassic Park*. With the help of John Schollar from the National Centre for Biotechnology Education, I developed a resource based on the concept of DNA as a 'recipe for life'. This aimed to give a basic understanding of the role of DNA within human cells and an appreciation that it is the uniqueness of their DNA 'recipes' that makes individuals different.



Fig. 1. *Discovering DNA: The Recipe for Life* can be downloaded from [www.bbsrc.ac.uk/society/schools/secondary/discovering-dna.aspx](http://www.bbsrc.ac.uk/society/schools/secondary/discovering-dna.aspx). BBSRC

*Discovering DNA: The Recipe for Life* contains seven curriculum-linked activities and was written for delivery as a 2-hour workshop (Fig. 1). Beginning with the hook of a chocolate swiss roll, it takes the audience from the concept of a recipe for a cake through to the 'recipe' for a human, using games, simple experiments, puzzles and model-making. The biggest challenge was to make the link between the base sequence and phenotype, an example of the dilemma often faced by science communicators of how to simplify without misleading. I tackled this by setting an activity in 'Cartoon Land' where the rules are straightforward and each feature of a face is encoded by a recipe of just five bases. Happy with this simple context, the children readily set about with scissors, glue and crayons to construct their own cartoon character and record its DNA recipe. From this foundation, we could then discuss the greater complexity of the human 'recipe' (Fig. 2).

Whilst I was serving cake and slicing onions, the agenda for science communication was changing, culminating in the publication of the House of Lords '*Science and Society*' report in 2000. Published at a time when public confidence in scientists was still reeling from the BSE crisis, the report noted that the attitude of British scientists had changed in favour of public outreach activities, but that '*the crisis of trust has produced a new mood for dialogue*'. The PUS movement that had evolved from the Bodmer report was felt to be too focussed on what the public did

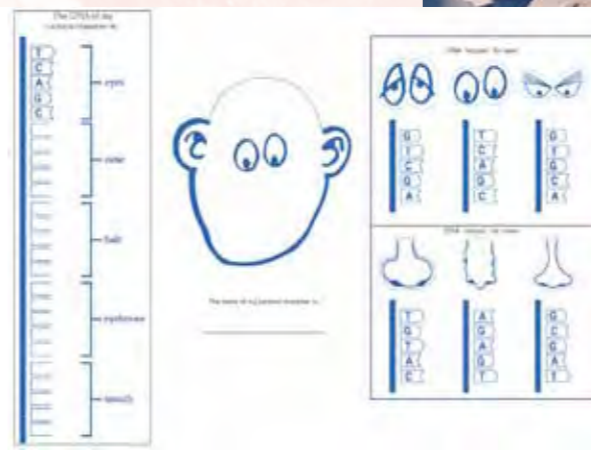


Fig. 2. Making the link between base sequence and phenotype in 'Cartoon Land', one of the activities in *Discovering DNA: The Recipe for Life*. BBSRC / S. Assinder





not know, with the implication that scientists just needed to provide sufficient information to overcome a 'knowledge deficit'. As a result of the House of Lords Report, 'public understanding' evolved into 'public engagement' and the interaction between scientists and the public started to be seen as a 2-way process. Some scientists took the route of dialogue and debate, with activities such as consultations, citizens' juries, focus groups and science cafés around issues of public concern. Others concentrated on finding different ways of working with the public that were less dominated by the 'expert in the white coat' and more focussed on interacting and listening.

The 'Fungal Village' was one such project. I was approached by Mike Milner from the British Trust for Conservation Volunteers to run some educational activities at a community event in Heddon-on-the-Wall in Northumberland. As Education Officer at that time of the British Mycological Society (BMS), I had been working with Gordon Rutter and other BMS members to collate a teaching resource about fungi, so this was an opportunity to try out some ideas. We chose activities to get across three messages: fungi occur in vast numbers and in all shapes and sizes, they play a vital ecological role and they can be exploited for our benefit. As it turned out, the abundance and diversity of fungi were obvious – weeks of warm, wet weather helped participants to collect over 50 species in under 2 hours without straying more than 500 metres from the car park. The result of a weekend of hectic activity was *How the Mushroom got its Spots*, a booklet published jointly by the BMS and the BBSRC. The booklet contains games, puzzles and quizzes for use by anyone wanting to introduce non-experts of any age to the fascinating world of fungi, including



Fig. 3. *Amanita muscaria* lookalikes produced from the eponymous activity in *How the Mushroom got its Spots*. S. Assinder

the eponymous activity to produce a fly agaric mushroom (*Amanita muscaria*) using a balloon, tissue paper and a good pair of lungs (Fig. 3). What made the fungal village project so valuable was that it was a genuine dialogue. The science that the villagers of Heddon learnt from us was balanced by what we learnt from them about how we should communicate that science.

A recent development has been the establishment of *Beacons for Public Engagement*, a £9.2m initiative funded by the UK higher education funding councils, Research Councils UK and the Wellcome Trust, to establish a co-ordinated approach to recognizing, rewarding and building capacity for public engagement. Despite the legitimacy conferred by such high-profile initiatives, many scientists still perceive barriers to their getting involved in science communication, not least the need to maximize performance in the Research Assessment Exercise. There is no simple response to this other than to point out the benefits. My enthusiasm for communicating science has taken me from primary schools and draughty village halls to the Royal Show and the House of Lords. It has affected whole aspects of my life – I can no longer cut up an onion without wanting to extract its DNA, nor can I think of body glitter as anything other than a model for the cold virus in mucus. My involvement has undoubtedly made me a more effective teacher, and activities developed for my outreach work have found a second life as teaching aids for undergraduates. Above all, I have had a huge amount of fun.

What is the role of science communicators looking forward? Although the deficit model has fallen out of favour, unless scientists can explain science in a way that the non-expert can understand, there can be no dialogue. Scientists must also recognize that, with the rise of the internet and greater media coverage of science, the public begins the dialogue from a different starting point. It is only by understanding our audience and by getting the right balance between transmission of information and participation that we can provide the public with the facts that equip them to engage effectively in dialogue over scientific issues.

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*How the Mushroom got its Spots* can be downloaded from [www.bbsrc.ac.uk/society/schools/primary/mushroom-spots.aspx](http://www.bbsrc.ac.uk/society/schools/primary/mushroom-spots.aspx)

# Save the date:

## 16–18 November 2011

### Federation of Infection Societies Scientific Conference 2011

## 16–18 November 2011

## Manchester Central, Manchester UK

The Federation of Infection Societies Scientific Conference 2011 will take place at Manchester Central Convention Complex from Wednesday 16 to Friday 18 November 2011.

Join us for a broad programme covering a range of important topics in infectious disease.

Programme and registration will be available from February 2011.

FEDERATION OF  
**infection societies**  
CONFERENCE 2011





Haitian women collecting water.  
Wesley Boxce / Science Photo Library

# Cholera: an epidemic in Haiti

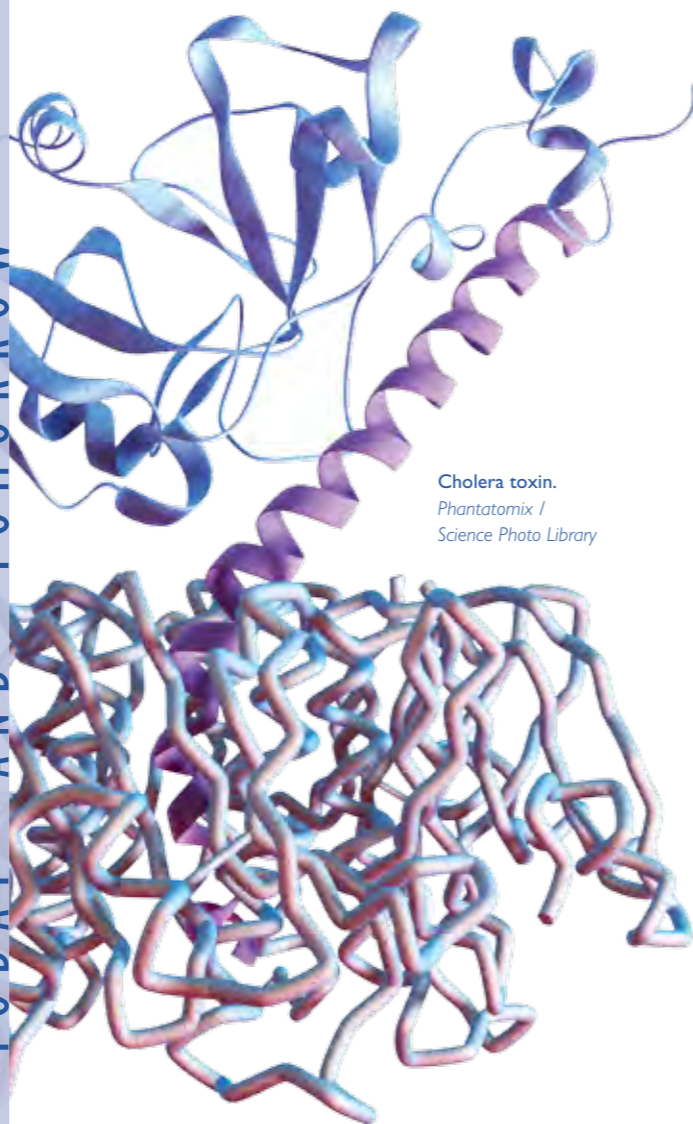


Polluted water  
in Haiti. Wesley  
Boxce / Science  
Photo Library

On 12 January 2010 Haiti was shaken by an earthquake of 7.0 Mw, with the epicentre located 16 miles west of the country's capital, Port-au-Prince. More than 3 million people were estimated to be affected by the quake with half a million dead or injured.

More than one year on, the country is slowly putting itself back together. However, the enemy is now disease. Due to poor sanitation and a lack of clean water, an outbreak of cholera was reported in October 2010. The outbreak began in the Artibonite region in the north of Haiti; the source was suspected

MICROBIOLOGY EDUCATION TODAY AND TOMORROW



Cholera toxin.  
Phantatomix /  
Science Photo Library

to be the Artibonite river where people had been taking their drinking water. Reports from the United Nations suggest that the epidemic could affect 650,000 people, having already killed at least 2,800 and infecting more than 130,000.

Cholera is a diarrhoeal disease caused by the ingestion of food or water contaminated with the parasite *Vibrio cholerae*. The bacterium releases a toxin which causes rapid fluid loss from the body into the digestive tract, which leads to dehydration and ultimately death by diarrhoea.

### COMING SOON...

...a 12-page fact file from the SGM, all about cholera, charting the history of the disease and investigating the cause, symptoms, diagnosis, treatment and prevention of the disease, as well as vaccine development and community education strategies. The resource, *Cholera: Death by Diarrhoea* is targeted at the post-16 age group and will be made available to SGM school members.

Don't forget we have a wide range of resources which can be used across the key stages. These can be viewed at [www.microbiologyonline.org.uk/teachers/resources](http://www.microbiologyonline.org.uk/teachers/resources)



*Rhodymenia*  
(red dulse  
seaweed).  
Dr Keith  
Wheeler /  
Science Photo  
Library

# Call for evaluation volunteers

Each resource will contain all the information needed to successfully carry out each of the practical classes, encompassing teaching instructions, a technician guide and student guide, as well as video clips and images, FAQs and a PowerPoint presentation. The first resource will focus on algae as a tool for the demonstration of a range of scientific concepts noted in the science specification.

Algae are a diverse group of organisms – they can exist as single cells, e.g. *Chlamydomonas*, joined together in chains like *Spirogyra* or made up of many cells, for instance *Rhodymenia*.

Algae are often overlooked when people think of micro-organisms. They may be dismissed as being rather dull, and not of great importance because they do not often cause disease. However, they are of substantial significance to the world around us. The microalgae are a major component of the oceans' phytoplankton, featuring in many food chains, and they remove carbon dioxide from the air, replacing it with oxygen.

Microalgae have a lot of potential for fun yet thought-provoking and educational school laboratory practical exercises. Not only do they represent a safe, easy-to-handle and cheap micro-organism to use in schools, they also have great potential to illustrate numerous scientific concepts, such as photosynthesis, phototaxis (moving towards a light stimulus), bioluminescence (emitting light in the dark), eutrophication (population explosion within a body of water) and biofuels. The

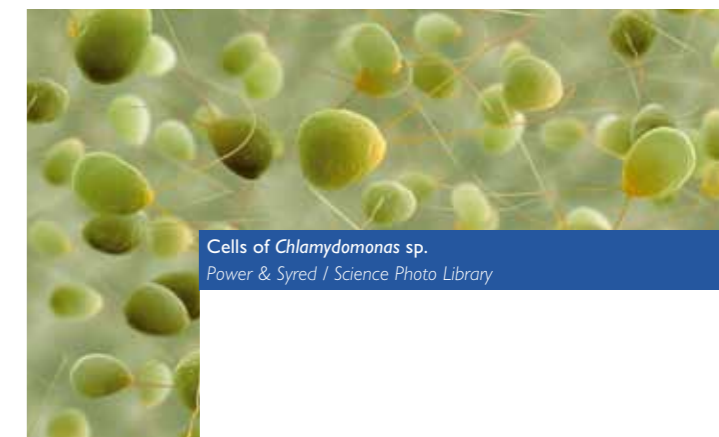
James Redfern, a postgraduate student at Manchester Metropolitan University, is developing a series of exciting microbiology laboratory practical exercises aimed at KS3, GCSE & A Level students, to be distributed to SGM school members, and to be included on the SGM education website. Here, he describes his project and includes a call for assistance in evaluation.

algae resource will encompass these five topics, supplemented by microscopy and classification keys for the differentiation of common environmental microalgae.

As part of their design, all the resources will be fully tested for reproducibility. Part of this testing will include a series of evaluations by students (university and school) and teachers. We intend to launch the completed package for the 2011–2012 academic year.

So, we are looking for key stage 3/GCSE science teachers who have a keen interest in practical science, who are looking for new, safe, educational and fun ways to bring practical microbiology into the classroom. The pre-launch evaluations are likely to be held at one of the Science Learning Centres (either East Midlands, or the National Science Learning Centre in York) over the last two weeks of the summer term in 2011. SGM will cover expenses, and those schools who do get involved with the trial will be acknowledged in the resource. Post-launch, we will also be keen to evaluate impact.

If you are interested in taking part in the evaluations, please email James at [james.redfern@stu.mmu.ac.uk](mailto:james.redfern@stu.mmu.ac.uk)



Cells of *Chlamydomonas* sp.  
Power & Syred / Science Photo Library



Stockphoto / Thinkstock



James Redfern on the SGM stand. V. Symington

# ASE Reading 2011

*'Travel broadens the mind but opens the bowels'* (P.D. Welsby, 2005)

**THIS YEAR'S ASE** (Association for Science Education) Conference was held at the University of Reading from 5 to 8 January. The SGM shared a stand with the Association of British Pharmaceutical Industries (ABPI) and the Microbiology in Schools Advisory Committee (MiSAC), and also took part in a day of talks sponsored by the NUCLEUS group.

NUCLEUS is a group of learned societies who are involved with promoting bioscience education; amongst other things, members of NUCLEUS get together to sponsor a day at the ASE entitled *Biology in the Real World*. Eminent speakers from the societies' disciplines give talks which aim to bring the biology curriculum to life while maintaining a link to the biology specifications. This year the talk sponsored by the SGM was given by Professor Martin Adams (University of Surrey), entitled *Prevent travellers' diarrhoea – boil it, peel it, cook it or forget it!*

Martin began by giving the definition of a loose stool as 'one which forms the shape of the container into which it is deposited' – a delightful thought at 9.30am on a Friday morning! He then gave a thorough account of the countries to avoid in terms of incidence of diarrhoeal disease and the microbial culprits of the discomfort. We were introduced to the different virotypes of *Escherichia coli*, the most common cause of travellers' diarrhoea (TD), including: enterotoxigenic (ETEC), enteropathogenic (EPEC), enteroinvasive (EIAEC), enteroaggregative (EAEC) and enterohaemorrhagic (EHEC) *E. coli*; along with a multitude of other 'nasties' with which we might have contact should we dare venture on holiday! He was keen to point out that the true incidence of TD is unknown due to many cases that go untested and unreported, the majority 'passing' quickly without real cause for concern.

Martin delivered his talk in an entertaining and engaging manner, making the audience aware of faecal accidents, of ways to contract *Salmonella* from your terrapin, and that infection with *Campylobacter* may feel like 'the world dropping out of your bottom, not vice versa!'

Elsewhere at ASE, the SGM stand was a raging success with resources flying off the shelves. Manning the stand, James Redfern, Yvonne Taylor, Laura Udakis, Dariel Burdass and I had some really interesting discussions with conference delegates who we hope are all going back to their schools ready to take microbiology by the horns! I also gave a short talk at the Open Conference Session, introducing delegates to SGM education materials, which was gladly received by the teachers in attendance.

We are very grateful to Martin for his contribution to our success at this year's ASE. He has kindly helped us to update an article which was published in *Microbiology Today* in August 2010 and this is now being distributed to all School Corporate Members.

**VICKI SYMINGTON**  
Education and Outreach Administrator

A student browses SGM educational materials on the display. V. Symington

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

istockphoto / Thinkstock



UPDATES AND ADVICE FOR EARLY CAREER MICROBIOLOGISTS

Pursuing and advancing knowledge is a global venture, with people from many countries interacting and collaborating with one another. Researchers are now likely to spend part of their career in a foreign country. Karen McGregor offers some sound advice and insight from her own experiences.

## Microbiology – an international career

**MOVING TO A NEW COUNTRY** can be an exciting and rewarding experience, expanding both professional and personal horizons. However, it is not always easy to uproot yourself from familiar surroundings (see Table below). While it can seem daunting, good preparation and planning can help the move go as smoothly as possible and ensure its success.

### PLANNING THE MOVE

When applying for advertised positions, it is helpful to find out about the application process in that country and how it differs from your own. (e.g. how long and detailed the CV should be).

There are a few things to consider/ask when looking at a potential post.

- Does it include a relocation package (sadly, these aren't as common, or generous, as they used to be)?
- Will someone help you to find accommodation?
- Is there an induction course for international researchers?
- Is there a mentor scheme?
- Is there a central office that can deal with queries about visas (and help you with the application process)?

Don't underestimate the time (and cost) of organizing a visa, and read carefully any instructions on paperwork you need to have with you when you enter the country for the first time – border control personnel are not generally known for their understanding and compassionate nature.

Potential upsides	Potential downsides
- Quality/reputation of research at institution	- Practical difficulties (managing finances, family issues, tax, etc.)
- Access to facilities and expertise	
- Building networks/collaborations	- Language barrier
- Improved career prospects (but not always)	- Likely to be a temporary/fixed term position
- Cultural enhancement	- Cultural differences
- Salary, level of bureaucracy, cost/standard of living	- Salary, level of bureaucracy, cost/standard of living
- The food	- The food
- The weather	- The weather
- Adventure and new experiences	- Lack of integration and sense of isolation from family and friends

istockphoto / Thinkstock





You should expect the unexpected (and have money put aside for it). When I moved to the UK, I had carefully budgeted what I would spend on accommodation and duly signed up for a lovely little flat. Then I found out about council tax (in Australia the landlord, not the tenant, pays the rates/tax on rental properties). And what do you mean you have to pay for having a television!

Get as much information as you can to make an informed choice. Ask people who have previously moved country about their experiences and recommendations. It is a good idea to find out about the research landscape in the country you are considering moving to, and also to check out the lab you will be working in. Ask your potential employer for contact details of another early-career researcher who has moved to that institute – ideally from your country – and then find out from them about the general working conditions and social life.

### THE MOVE ITSELF

Try to find out (and do) as much as possible before you make the move. Bear in mind that moving will cost more than you think and you'll probably be paid in arrears (most likely at the end of the month). Until pay day, you'll have to cover day-to-day expenses as well as a variety of deposits and/or installation fees, so you'll need to have enough accessible funds in your new location.

Plan a budget for particular items. Find out all you can to build a realistic picture of what your monthly expenses will be (for utilities, tax, pension, insurance, transport, food) and then work out what the maximum is that you are willing to spend on accommodation (leaving you enough left over to socialize, go on holiday, etc.). Other things (but not everything) that you will need to think about include:

- healthcare (registration requirements, any entitlements to reduced-cost medical treatment);
- pensions (is it worth transferring any benefits from existing pension schemes?);
- driving (road rules, insurance requirements) / public transport (timetable, long-term passes, any discounts);
- politics and voting;
- family issues (education, childcare, benefits, maternity leave entitlements).

### GETTING THE MOST OUT OF THE MOVE

First, don't be afraid to ask questions from those around you – many of your colleagues may well have moved at some stage and will understand how daunting it is. Most importantly, get involved. This can include joining the research staff association, offering to help run the departmental seminar program, or just eating

44% of UK doctoral graduates are from overseas. Even if you are not thinking of going abroad yourself, maybe after reading this article you'll be more inclined to go out of your way to introduce yourself to the new foreigner in your department, or even invite them to go for coffee.

your lunch with others in the common/staff room rather than at your desk. Engaging socially is important for most people's general sanity and happiness. In some places this will be easy (some departments will already have an active programme of social activities); in others, it will be more challenging (social activities may not occur regularly or it can be hard to garner enthusiasm in a 'too busy' culture). If you fall into the latter, don't despair: there should be opportunities to join a group such as an international society.

Don't forget to take advantage of any career development opportunities/training that might be on offer. And make time to contact friends and family at home.

### THINKING BEYOND THE MOVE

It is true of any new job, but particularly for an international move, that you should start thinking at an early stage about what you might do at the end of the contract. If your intention is to return to your country of origin, it is a good idea to have a return strategy. Keep up to date with research developments and funding opportunities, and stay in contact with researchers you know in your home country. Attending conferences is good for face-to-face networking with researchers from home and abroad.

### KAREN MCGREGOR

Membership Services and Grants Administrator



Dr Claire McNulty from the British Council describes her own experience of international research as well as an important resource freely available to researchers considering a move within Europe.

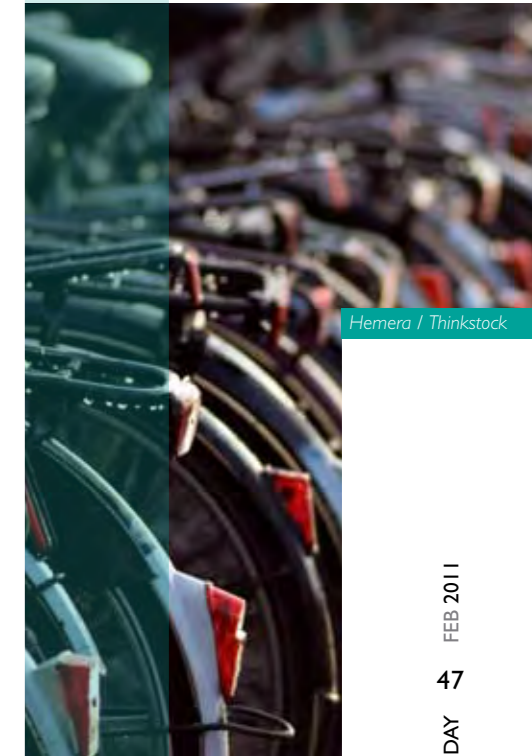
## The EURAXESS initiative

TEN YEARS AGO, when I arrived in the Netherlands as a young postdoc, I was naturally a bit nervous. It was the first step of my research career and, beyond the stereotypes of bikes, cheese and tulips, I was not really sure what to expect. I grew to love Holland and my life as a researcher there, but it wasn't easy. It was hard at first to fit into the research hierarchies, especially as, having been through the UK system, I was younger than many PhD researchers, who are classified as members of staff, not students in the Dutch system. Issues like understanding the tax system and finding affordable accommodation seemed much more complicated. For example, I only found out about a tax rule which allowed skilled foreigners to pay a lower rate of tax when it was too late to apply.

Living and working in the Netherlands was an immensely

valuable experience for me, both professionally and personally (I started my family there), but there were times when I would have appreciated some targeted advice about how to get by as a researcher. Now, through my work in the British Council's Science team I know that advice does exist, in the form of the EURAXESS initiative.

The British Council is the UK partner organization for the EURAXESS project and we run the EURAXESS-UK portal ([www.euraxess.org.uk](http://www.euraxess.org.uk)), because we believe in the importance of sharing knowledge and ideas across national boundaries. EURAXESS is a Europe-wide project (spanning most European countries, including non-member states such as Turkey and Iceland) that tries to make it easier for researchers to move around from country to country; this includes support



Hemera / Thinkstock

for international researchers moving to the UK as well as UK researchers moving across Europe. It has four key strands; Jobs, Services, Rights and Links (see diagram below).

### EURAXESS JOBS

An online database of research jobs and funding in Europe. It is free to advertise and search for vacancies and if you register you can upload your CV so potential employers can approach you directly.

### EURAXESS RIGHTS

Information about the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers to help you understand your rights as a researcher in Europe (and your employer's responsibilities to you).

### EURAXESS SERVICES

> 35 national portals with information, specifically targeted at researchers and their families, to help you navigate your way round a new country. They give information on the research landscape, funding, visas and work permits, tax, legal and social security systems, as well as more general issues, like how to access medical care, find childcare or open a bank account. Many of the portals provide local contact points where you can get free personalised assistance on all matters relating to your professional and daily life.

### EURAXESS LINKS

A networking tool to provide current information on European research to researchers based outside Europe. Includes opportunities for funding and international collaboration.





The British Council have a number of other projects and initiatives that support international researchers in Europe and other parts of the world (including supporting science communication through initiatives such as FameLab and Talking Science). Throughout all our work, we focus on the core goal of connecting people. The British Council believes that creating opportunities for people to understand each other better, work together more and learn from one another is crucial to building a secure, more prosperous and sustainable future for us all.

For more information on our work please visit our website ([www.britishcouncil.org](http://www.britishcouncil.org)), or for science-related enquiries contact [science@Britishcouncil.org](mailto:science@Britishcouncil.org)

#### CLAIRE MCULTY

Life Science Advisor, UK Science Team, British Council

#### FURTHER INFORMATION

##### FINDING A JOB

- Academic jobs EU – [academicjobseu.com](http://academicjobseu.com)
- Euro Science jobs – [eurosciencejobs.com/jobs/biology](http://eurosciencejobs.com/jobs/biology)
- USA/Canada – <http://jobs.phds.org/>

##### FUNDING OPPORTUNITIES

- ERC (European Research Council) – [erc.europa.eu](http://erc.europa.eu)
- Marie Curie Actions – [cordis.europa.eu/fp7/people/home\\_en.html](http://cordis.europa.eu/fp7/people/home_en.html)
- SISTER – [www.britishcouncil.org/science-sister.htm](http://www.britishcouncil.org/science-sister.htm) – a guide to international research funding opportunities (including support for collaborations and travel grants)
- Access4EU – [www.access4.eu](http://www.access4.eu) – opportunities for research, innovation and capacity building projects in 11 countries worldwide (including the US, China, Brazil and Australia)
- UK-India Education and Research Initiative – [www.ukieri.org](http://www.ukieri.org) – funding for joint research projects

##### INFORMATION ON THE RESEARCH LANDSCAPE AND SUPPORT FOR RESEARCHERS

- LERU (League of European Research Universities) – [www.leru.org](http://www.leru.org)
- Eurodoc – [www.eurodoc.net/](http://www.eurodoc.net/) – federation of national associations of PhD candidates and young researchers

#### PROFILE – ARWYN EDWARDS

Lecturer in Biology (Welsh Medium Delivery), Institute of Biological, Environmental and Rural Sciences, Aberystwyth University

My research interest is the structure and function of microbial communities on, in and underneath glaciers. I'm most fascinated by cryoconite holes which, despite average temperatures of <math><1^{\circ}\text{C}</math>, possess microbial activity rates similar to temperate soils. For obvious reasons, travelling for fieldwork is obligatory for UK-based glacier microbiologists and I've previously spent a few summers 600 miles from the North Pole at the NERC Arctic Research Station on Svalbard. It was during these trips that I met Dr Birgit Sattler, a leading expert in polar microbiology based at the Institute of Ecology in Innsbruck, Austria. What began with discussions over whisky on the rocks (glacial ice, of course) on Svalbard, progressed to regular email contact and working on a manuscript together. I mentioned the SGM President's Fund scheme and Birgit was happy to welcome me to Innsbruck. She had just started a project looking at a glacier in the Tyrolean Alps based at Innsbruck University's Alpine Research Centre in Obergurgl, and this was a great opportunity for me to expand my research interests from Arctic to Alpine environments.

I made the trip to Austria in September 2010. There was good weather for our main

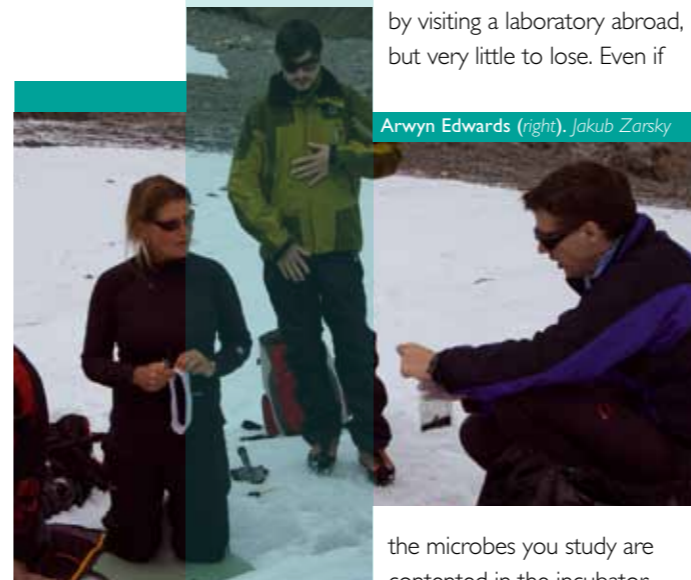
## A taste

SGM President's Fund for Research Visit Grants offer eligible members the chance to carry out a short research visit at another lab (details on page 8). Two recent recipients of funds from this scheme reflect on their experiences.

field campaign and the snowline stayed high enough for us to find plenty of cryoconite to sample most days. A particular highlight was the day that started with a 3,200 m cable car ride followed by a good old scramble to get to an untried glacier; the sun was shining, the view was breathtaking, the sampling was good and we even managed to get a lift down in a SnowCat!

There are, of course, challenges associated with this type of fieldwork, starting with developing cunning ways of defeating maximum baggage allowances to get crampons, ice axes, sample tubes, etc., on the plane from Wales to Austria! The physicality of getting to sampling locations, and back again, means that I no longer take my knees for granted.

This visit, and the grant provided by SGM, has been invaluable for my career. Even before I'd set foot in Austria, the grant gave me something concrete to present to job interview panels regarding my



Arwyn Edwards (right), Jakub Zarsky

research plans. I'm already planning a return visit next spring to write up the outcomes of this trip for publication and to discuss future collaborations. In the meantime, one of Dr Sattler's students has received funding to visit my laboratory to conduct molecular analyses of bacterial communities in snow and ice, further strengthening Aberystwyth-Innsbruck links.

I'm very grateful to the SGM for this great opportunity and would recommend other young scientists to apply. There is a lot you can gain and give by visiting a laboratory abroad, but very little to lose. Even if

the microbes you study are contented in the incubator at the end of your bench, international work experience adds considerable value to your career profile and perspective as a scientist. International collaborations are the lifeblood of cutting-edge science; if we in the UK aspire to do world-class science, we must engage with science across the world. That level of engagement cannot be obtained by email, although an email is often the start of something more meaningful.

## of international research

#### PROFILE – NEELTJE VAN DOREMALEN

PhD student at Imperial College London

I have been fortunate enough to experience international research in a number of settings. During my degree, in The Netherlands, I did a 6-month internship at King's College London and enjoyed the research and city thoroughly. When it came to finding a PhD project, I was keen to return to the UK.

My PhD project, supervised by Prof. Wendy Barclay, is looking at mutations in the influenza virus haemagglutinin protein and their relationship to human-to-human transmission of the virus. I wanted to look at the binding of my viruses to non-ciliated cells in a human airway epithelial system, but we do not have this system in the lab.

Due to Prof. Barclay's long-standing collaboration with Prof. Ray Pickles, University of



Neeltje van Doremalen

North Carolina, USA, and with funding from the SGM President's Fund scheme, I was able to visit Prof. Pickles' in May-June 2010 to undertake these experiments. As some lab members had previously travelled

between the two labs, preparing for the visit was made easier as I could learn from their experiences. The most stressful part was making sure the viruses were ready on time and organizing their transport. As I was only there for 4 weeks, every experiment had to be planned very carefully to ensure I got the most out of my visit.

The visit itself was amazing. I really enjoyed working with Prof. Pickles; because his expertise is in a different area to mine, he looked at experiments from a different perspective and this was very refreshing. I have already presented the results from my visit at a conference in Hong Kong.

I have enjoyed living in different countries and working with people from all over the world. I believe having worked in other countries has been very beneficial for my CV as it shows potential employers that I am proactive in my career. I was lucky in organizing my visit to the USA as there was already a collaboration in place. But if you think you have an interesting project and a good reason to work in another laboratory, I would absolutely recommend working abroad to you.

#### Sense About Science media workshop

Sense About Science will be holding a *Standing up for Science* media workshop at the University of Manchester on Friday 11 March. This full-day event is free and for early-career researchers in all sciences (PhD students, postdocs or equivalent in first job). Please find further information at [www.senseaboutscience.org.uk/PDF/Manchester\\_flyer\\_0311.pdf](http://www.senseaboutscience.org.uk/PDF/Manchester_flyer_0311.pdf). These workshops are very popular and places are limited. To apply, send a CV and covering letter explaining your reasons for applying, and stating any affiliations you hold to Rose Wu ([rwu@senseaboutscience.org](mailto:rwu@senseaboutscience.org)). The closing date for applications is Monday 28 February.



# MANCHESTER SCIENCE FESTIVAL 2010



The Manchester Science Festival (MSF) attracts over 100,000 visitors during its week-long run. There were more than 200 events at the 2010 festival which took place in several venues across the city. Split over four themed areas: 'Manchesticity', 'Mind & body', 'Our planet & beyond' and 'Bright ideas', there was plenty to choose from, including walks, talks, workshops, shows, comedy, cake, exhibitions and busking – all with a science flavour. Vicki Symington and Jo Verran present their views of the event.



**IF YOU WERE WANDERING** around the Power Hall in Manchester's Museum of Science and Industry (MOSI) during Halloween weekend last year you might have been surprised to find the SGM staff blowing up balloons using the 'power of yeast!' Not put off being surrounded by locomotive engines, more than 400 children took part in our activity!

**GETTING UP AND RUNNING**  
With only a few minor teething problems – where to park the van being foremost – Dariel, Laura, Yvonne, James and I arrived armed with our fancy new water bath and plasma screen TV, not to mention our new yeast resource (with at-home science experiments), 'bad bug' bookmarks and 'good bug' bendy rulers! We were blowing up balloons using dried yeast, sugar and warm water, then measuring their circumference, carefully plotting the results on our graph. The

biggest balloon of the weekend had a 31 cm circumference after 45 minutes inflating time!

**FEEDBACK**  
As SGM had never been to MSF, we didn't know what to expect. There was a steady flow of people across the weekend and, because the activities were not densely packed into one hall, people were very interested in what was going on and why we were there ... particularly in amongst the trains!

Many of the children and adults were unaware that yeast was a living organism, let alone a microbe; in particular, many had assumed that dried yeast contained a chemical agent that helped bread to rise. There was genuine amazement on the faces of some of the young people! Questions varied massively from 'would the balloon explode if you just left it for hours and hours?' to in-depth queries as to the different



TAKING MICROBIOLOGY TO THE PUBLIC



Photos show the SGM stand and staff (Vicki, Yvonne and Laura) during the 2010 Manchester Science Festival.  
V. Symington



**THE BAD BUGS BOOKCLUB** met during the festival. The bookclub comprises a group of scientists and non-scientists who meet regularly through the year to discuss novels in which infectious disease forms part of the plot. Some of the books are overtly focussed on disease (for example *Year of Wonder* by Geraldine Brooks), whilst in others, microbiology forms a backdrop to the storyline (for example *Mary Barton* by Elizabeth Gaskell). At the Science Festival, the bookclub hosted its 7th meeting, this time using the Patricia Cornwell novel *The Body Farm* as the focus of discussion, with special

types of yeast which can be used in breadmaking and brewing to obtain the perfect rise and alcohol content, respectively!

There was a good response to our new resource, a cartoon all about yeast, with accompanying experiments to do at home, with both teachers and parents taking copies. This resource has now been distributed to all school members who can request multiple copies for class use. Non-members can request single copies via [www.microbiologyonline.org.uk](http://www.microbiologyonline.org.uk)

Children (and adults) of all ages were keen to get involved and try the experiment to see whose balloon would be the biggest. While this activity has been done before at previous SGM events, it remains an old favourite as it clearly demonstrates the power of microbes using simple, safe, household ingredients. We plan on wheeling this one out again for some

of the science festivals we are attending in the coming year if you are interested in seeing first hand what it's all about.

**VICKI SYMINGTON**  
Education and Outreach Administrator

guests Dariel and Vicki from SGM, who kindly sponsored the event. There were several forensic activities at the festival, so our book was intended to complement those proceedings. The discussion was accompanied by the screening of a television documentary about the real-life body farm, as described in the novel. This is a research facility in Tennessee where bodies are left to decompose under specified conditions, enabling findings to assist in the interpretation of cause of death. Fortunately, a past edition of *MT* (Nov 2001, p. 190) also contained an article about human decomposition, so we were able to use it to help tease out some microbiology during discussion – any direct microbiology content in the novel was, this time, rather thin. Despite the gruesome nature of the documentary, we bravely struggled through the refreshments provided and we carried away the book in a nice SGM canvas bag, along with a useful SGM pen.



It was certainly not a problem consuming the victuals at the *Teawitter* event, which was set up by a group of social networkers, enabling them to get together in person on a Sunday afternoon every few months, along with tea and cakes. This time, there was a science theme – even the amazing cakes played along, with a cup-cake periodic table stealing the show. I was asked to talk about microbiology, tea and cakes ... surprisingly easy actually, once I had time to think up possible links. I used Vicki's *Yeast Power* demonstration (yeast plus sugar plus warm water plus balloon) as a timer for the event (when the balloon stood up, it was time to finish), and described the importance of microbes in tea, coffee and chocolate fermentation, used creative cakes to illustrate food-poisoning micro-organisms (see *MT* Aug 2010, p. 190), and finished with a reminder about tooth decay (which no-one heeded)! Between additional cake-eating, there was also a demonstration of making ice cream with liquid nitrogen (under appropriate safety conditions) and a talk on mathematical modelling of crowd management, which was almost essential when the audience milled around the SGM goodies (and the cakes).

World AIDS Day on 1 December marked the anniversary of the launch of the SGM-sponsored community 'respect + protect' quilt. The quilt, featured in *MT* Feb 2009 (p. 55) now needs a permanent home – if you have any suggestions, please contact Dariel Burdass (d.burdass@sgm.ac.uk). We marked the occasion with another bookclub meeting, this time using *Dracula* by Bram Stoker. Previous public engagement activities had linked the *Twilight* vampire novels with microbiology (see *MT* Nov 2010, p. 248), so we thought we would go back to the first vampire blockbuster. We were surprised at what a good read it was, full of reference to contemporary technological advances (of the late 1800s), feminism (pre-suffragettes) and of course the sensuality of vampirism. It must have been really shocking when first published. Plenty of science too – blood transfusions and symptoms reminiscent of rabies, consumption, syphilis, etc. We distributed SGM's HIV information to the participants.

I have used loads of SGM's resources at different events and really value their availability. The range is such that there is always something appropriate for a given audience and the availability of *MT* articles via the website is an additional boon. Information is attractive, relevant and up-to-date, and the small gifts (bags, pens, stickers, etc.) are always welcome. I am sure that the continuing efforts of the Society in awareness-raising and education are noted and appreciated by all concerned – so many thanks Marlborough House!

**JO VERRAN** SGM Education and Public Affairs Officer



Top. A meeting of the *Dracula* bookclub.

Above & right. Cakes from the *Teawitter* event, including part of the cupcake periodic table, one of the organizers, Naomi Jacobs, with some of the cakes, and a rainbow sponge cake. J. Verran

Right. Jo Verran with the 'respect + protect' quilt. J. Verran



## SCIENCE AND THE PARLIAMENT 2010

**SCIENCE** and the Parliament is the biggest annual gathering of the science and political communities in Scotland. It is organized by the Royal Society of Chemistry, in association with over 30 science and engineering societies and organizations, and provides a forum to focus on the best of, and also the priorities for science in Scotland.

The theme of this year's event was focussed on looking forward to the Scottish Parliamentary Elections due in May 2011 and identifying issues and policies that the scientific community would like to see, incorporated into the Election Manifestos of the major political parties.

The President of the RSC, Professor David Phillips, chaired the event. Other distinguished speakers included Iain Gray, Leader of the Labour Party in the Scottish Parliament, as well as Members of the Scottish Parliament from all the major political parties. Other major contributors to the proceedings included Professor Anne Glover, Chief Scientific Adviser to the Scottish Government, Professor Paul Hagan, Director of Research and Innovation, Scottish Funding Council, and Dr Oonagh Loughran, Life Science Priority Industry Team, Scottish Enterprise.



Hilary and Ron Fraser manning the SGM stand. R. Fraser

Breakout sessions followed the presentations, which addressed four policy areas: Education, Energy and the Environment, Enterprise, and Health.

A reception and exhibition followed the day's proceedings. The SGM stand focussed on reducing the spread of infection. The display was both interactive and informative, and highlighted the importance of good hand hygiene in reducing the microbial load on the skin and how this can help to prevent the spread of infections such as the common cold and influenza.

Flyers on hand hygiene, MRSA and *Clostridium difficile*, as well as hand-soaps, were available on the stand for the delegates to take away.

The day concluded with a debate on science in the chamber of the Scottish Parliament. Bill Wilson (West of Scotland) (Scottish National Party) submitted the following motion for discussion: *'That the Parliament welcomes the Science and the Parliament event that is scheduled to be held on 10 November 2010 in Our Dynamic Earth and organized by the Royal Society of Chemistry in association with Scotland's leading science organizations; notes the contribution of Scotland's scientists to economic, environmental and social development through the University of the West of Scotland and James Watt College and companies such as BASF and Life Technologies in Paisley; considers that Scotland is a world leader in many scientific disciplines, and recognizes the need to foster an environment that enhances pupil and student participation in science, to sustain science research along with supporting greater industrial research and to assist in the practical application of world-beating research.'*

**DARIEL BURDASS**  
Head of Education, Professional Affairs and Outreach



The Bad Bugs bookclub meeting at MSF. V. Symington





PROMOTING UNDERSTANDING AMONGST PARLIAMENTARIANS

The Society's Microbiology Awareness Campaign was first launched in 2004, and continues to evolve and go from strength to strength. It was set up to promote the understanding of microbiology and the important role of microbiologists to parliamentarians, opinion-formers and policy-makers through a comprehensive framework of activities designed to bring together microbiologists and key stakeholders, including members of Parliament and the House of Lords.

All photos  
Ian Atherton



**CLIMATE CHANGE** was the hot topic that was under the spotlight when the SGM held its latest Microbiology Awareness Campaign parliamentary event at the House of Lords on 3 November 2010, hosted by **Lord Soulsby of Swaffham Prior**.

Members of the Lords and MPs met with leading experts working in the field of climate change. More than 100 invitees gathered on The Terrace at the House of Lords to hear a series of short presentations on microbes as climate engineers, and the influence of climate change on disease and microbial environmental processes. We were delighted with the enthusiasm and interest that the audience showed for this hot topic. The talks were followed by a drinks reception, which provided an excellent networking opportunity for all



The SGM climate change banner.



MT and SGM pens on display.

the guests and the chance to view an exhibition from various organizations carrying out research in this hugely important area of microbiology.

After a short introductory speech from our host, Lord Soulsby of Swaffham Prior, **Professor Hilary Lappin-Scott**, SGM President, summarized the role and activities of the SGM and how the Society provides a common meeting ground for scientists working in research and in fields with applications in microbiology, including medicine, veterinary medicine, pharmaceuticals, numerous industries, agriculture, food, the environment and education.

**Dr Dave Reay**, University of Edinburgh, gave an overview of the role of microbes as climate engineers, the crucial role that they play in the carbon and nitrogen cycles, and how they are responsible for both using and producing greenhouse gases such as carbon dioxide and methane. Microbes can have positive and negative responses to temperature, making them an important component of climate change models. However, microbes live in diverse communities that interact with other organisms and the environment, making their impact difficult to predict. As he explained, *'Microbes will continue as climate engineers long after humans have burned*



On the terrace.

## CLIMATE CHANGE



IS A BIG CONCERN. BUT WHAT ROLE DO MICROBES PLAY IN THIS GLOBAL CHALLENGE?



## IN THE HOUSE OF LORDS

Attendees enjoying refreshments and visiting the various display stands after the presentations.





Dariel Burdass (SGM) and Laura Udakis (SGM) with the SGM banner.



Hilary Lappin-Scott (SGM President) (below), and Jane Westwell (SGM) and Paul Hoskisson (MT Editor) (left) on the terrace.



Yvonne Taylor (SGM) and Vicki Symington (SGM) on the reception desk.



that final barrel of oil. Whether they help to avoid dangerous climate change in the 21st century or push us even faster towards it is dependent on just how well we understand them'.

Professor Andrew Whiteley, Centre for Ecology and Hydrology, explored the impact of climate change on soil biodiversity, while Dr Ian Joint, Plymouth Marine Laboratory, looked at the impact of climate change on marine microbes.

The presentations were brought to a close by Professor Steve Lindsay, London School of Hygiene and Tropical Medicine, who took a closer look at how climate change may affect the future risk of malaria

and how climate change in the UK may increase the abundance of nuisance insects that will impact on public health, tourism and the economy.

Professor Joanna Verran, SGM Education & Public Affairs Officer, chaired a wide range of questions from the audience, including one on the impact of climate change on the spread of malaria to the UK. Professor Lindsay explained

that evidence suggests that climate change is not the main driver of malaria and that other environmental changes are far more important. Even if temperatures in the UK became high enough to allow the vector to survive, it still couldn't multiply due to lack of suitable breeding grounds. Professor Verran brought this most successful event to a close.

DISPLAYS

The following exhibitors all put on fascinating displays, which addressed some aspect of microbes and climate:

Andrew Whiteley (CEH; right) and David Reay (Edinburgh; far right) delivering their presentations



Rothamsted Research  
Health Protection Agency  
Plymouth Marine Laboratory  
Centre for Ecology and Hydrology

ACKNOWLEDGEMENTS

The Society is extremely grateful to all the contributors who made this Microbiology Awareness Campaign event such a huge success, especially the speakers and exhibitors. Thanks are also due to Lord Soulsby of Swaffham Prior for hosting the event and for much useful advice.

FOLLOW-UP

A follow-up letter was then sent to all Peers, MPs, MSPs, AMs and MLAs, suggesting new ways that we can build bridges between parliamentarians and the microbiology community, and how we can provide key political opinion-formers and policy-makers with unbiased information on the role that microbes play in key issues. All parliamentarians also received briefings on climate change and HIV, and the 2011 SGM calendar; the pictures used throughout the calendar highlight important microbiological events throughout the year.

Following this, a question was asked by Lord Dykes – and recorded in *Lords Hansard*, 6 December 2010, Column WA19: 'To ask Her Majesty's Government what support they will give to the work of the Society for General Microbiology' [HL4454] (see [www.publications.parliament.uk/pa/ld201011/ldhansrd/text/101206w0001.htm](http://www.publications.parliament.uk/pa/ld201011/ldhansrd/text/101206w0001.htm)). This shows that the continued work that the Society is doing in raising the profile of microbiology to key stakeholders is producing positive results.

DARIEL BURDASS

Head of Education, Professional Affairs and Outreach



HIV BRIEFING



THE LATEST BRIEFING

from the SGM was issued to parliamentarians just before World AIDS Day on 1 December last year.

World AIDS Day aims to raise awareness, to tackle HIV prejudice and prevent the spread of the virus.

The 2-page A4 briefing on HIV provides a concise account of the virus, how infection progresses, testing and treatment, and explains the difference between HIV and AIDS. It includes the latest global statistics from the World Health Organization and UNAIDS.

The next topic to be covered in our briefings series is H1N1 (2009) 'Swine Flu' and has been prepared in response to the resurgence of this infection.



Pages from the booklet distributed to all attendees.





# MICROBIOLOGY AT THE URDD EISTEDDFOD

**THE URDD EISTEDDFOD** ([www.urdd.org/eisteddfod/](http://www.urdd.org/eisteddfod/)) is one of Europe's largest youth festivals, taking place during the summer half-term school holiday, with the location alternating between north and south Wales. In addition to the main Eisteddfod competitions (music, dancing, recitation, etc.) there are over 100 peripheral stands and pavilions. In 2010, the Eisteddfod was held in the grounds of the National Trust's Llanerchaeron Estate, near Aberaeron, Ceredigion. Llanerchaeron is of particular microbiological interest because the lawn surrounding the mansion is home to diverse populations of grassland fungi, with 24 species of a single genus (*Hygrocybe* spp.) recorded there.

Due to the research interests of staff members from Aberystwyth University (IBERS), the focus of the exhibit was strongly mycological, with the main display posters (entitled *Pwdrlyn*, which translates as 'rotter' or 'wastrel' in the



Top right **Enfys Evans** minding the stand. Photos H. Davey (above and bottom left) and G. Wyn Griffith (all others).

matters scientific have received relatively little attention at the Urdd Eisteddfod, but this year the Urdd were persuaded to host a science pavilion named *Y GwyddonLe* ('the science place'). Some 17,000 people (mainly schoolchildren) visited the Eisteddfod on each of the 6 days, of whom about 2,000 (daily) visited *GwyddonLe*. As such, this new venture proved to be a great success, so we were very pleased to provide a showcase for microbiology at the event.

The star of the show was *Badhamia utricularis*, now a famous microbe having appeared in *Planet Earth* (episode 6). It is very similar in appearance to its better-studied relative *Physarum polycephalum*, but much easier to maintain. With small children, it was easier

Ceredigion dialect) illustrating the key role of fungi as decomposers of terrestrial plant debris. It also highlighted the importance of fungal conservation, an issue ignored in mainstream biodiversity conservation, but highly relevant here given our proximity to the Llanerchaeron lawn.

Whilst the National Eisteddfod has a long-established science pavilion,



to ask them if they could see the river flowing (cytoplasmic shuttle streaming) and to watch the reversal of cytoplasmic flow at 60 second intervals. It was quite noticeable how almost every single boy (but never any of the girls!) on seeing a microscope would fiddle with the focus knobs, stage levers, etc., before even peering into the eyepieces. We quickly realized the need to hide the stage with a cloth, leaving only the eyepieces visible.

The *Feel a Fungus* exhibit, basically two Petri dish bags placed in a box containing either dried or wetted basidiocarps of the ear fungus *Auricularia auricular-judae*, was also very popular (scored highly on yuck factor), though of dubious scientific value. To illustrate the importance of fungi in nature,

*Pwyswch y Pwdrlyn*, children were invited to compare the weights of two small logs and to guess why they differed so much in density. Few were aware of the unique role of white rot basidiomycetes in lignin decay, but even 5-year-olds knew which type of wood they would choose to make a chair from. The biotechnological importance of fungi was shown using burum (yeast) cultures to inflate balloons and, unfortunately, not everybody appreciated the 'hint of brewery' odour that permeated the whole pavilion by the end of the week.

In contrast to the younger children, it was disappointing to note the suspicion of many adults to fungi – 'is it poisonous if you eat it?'. Such questions are not asked of plants or animals, so mycophobia is deeply ingrained in Welsh (and British) culture!

We thank the BMS for the loan of models and the SGM for a grant from the Education Development Fund. We are also grateful to Carol Hobart and John Hedger for the inspiration for the display poster and the exhibits, respectively.

**GARETH WYN GRIFFITH, ENFYS EVANS, HAZEL DAVEY, ARWYN EDWARDS**  
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## RAISING THE PROFILE OF MICROBIOLOGY

### NSEW 2011

**NSEW** (National Science and Engineering Week) is a series of around 3,500 events which take place across the country over 10 days in March each year aimed at people of all ages and levels of scientific understanding. The activities celebrate all aspects of science and engineering, and their impacts on our lives. If you are interested in taking part in public outreach, this is the perfect time to test the water.

This year's theme is *Communication*, although if you find you cannot fit into this theme then don't worry – there are no restrictions on the area of science which you present. In fact, there are no restrictions on audience, venue, activity or who runs the events!

The British Science Association coordinates NSEW. If you are interested in taking part this year, have a look at their website ([www.britishsociety.org](http://www.britishsociety.org)) for more information, or for advice on an event which you have in mind, check out the SGM website ([www.sgm.ac.uk/education\\_careers](http://www.sgm.ac.uk/education_careers)).

The SGM is keen to support any members interested in taking part in public engagement exercises which promote microbiology. Please get in touch if you would like copies of any of our resources or freebies which you can hand out at your event. If you have any ideas, why not let us know – you could even write them up for *Microbiology Today*!

For further information, contact Vicki Symington ([v.symington@sgm.ac.uk](mailto:v.symington@sgm.ac.uk)).



**THE ARTICLE BY BHARGAVA** (Bhargava, 2010) ignores well-documented facts about the efficacy and safety of Bt-brinjal and the benefits it would bring to farmers and consumers (Chaudhary & Gaur, 2009; Kameswara Rao, 2009a, b, 2010). The points in Bhargava's article depart widely from recorded data.

Bt-brinjal, developed in India by Mahyco (7 hybrids), Tamil Nadu Agricultural University (4 varieties) and the University of Agricultural Sciences, Dharwad (6 varieties), has been thoroughly tested for product efficacy and biosafety, with the data evaluated by two Expert Committees. On that basis, the Genetic Engineering Approval Committee (GEAC) recommended the commercial release of Bt-brinjal, and several surveys have affirmed the benefits of Bt-brinjal (Kolady & Lesser, 2005, 2006, 2008; Krishna & Qaim, 2007). In 2010, the Indian Minister for Environment and Forests (MoEF) imposed an indefinite moratorium on Bt-brinjal, overriding the approval of the GEAC for its commercial release. The MoEF's decision was not based on scientific or environmental concerns, but on political expediency (Kameswara Rao, 2010). The public consultation process conducted by the MoEF did not provide opportunity for the scientific community to express their opinion, as it was orchestrated in such a way as to support the MoEF's decision (Kameswara Rao, 2010).

Biosafety data for the Indian Bt-brinjal were not provided by Monsanto (Bhargava, 2010), but by the Indian developers, supported by several public sector institutions (Chaudhary & Gaur, 2010; Kameswara Rao, 2010).

The brinjal shoot and fruit borer (SFB) *Leucinodes orbonalis* is almost entirely monophagous and no variety of brinjal is resistant. The brinjal farmers suffer 50–70% losses of marketable yield. Integrated pest management and biopesticides have not been successful in controlling SFB (Krishna & Qaim, 2007). The polyphagous American bollworm (*Helicoverpa armigera*) also causes significant damage to brinjal fruits. Both pests on brinjal were shown to be effectively controlled by the Bt-gene Cry1Ac leading to a 133% average increase in yield and 77% reduction in pesticide application (Chaudhary & Gaur, 2009), very sound reasons for introducing Bt-brinjal into the Indian market, not to mention lowering environmental pollution and chemical exposure to people working in brinjal fields. The report of development of resistance by a cotton pest in parts of the Gujarat State in India (Bhargava, 2010) actually refers to the pink bollworm (not targeted by Cry1Ac) and not the American, which has not developed any resistance to Cry1Ac protein. Bhargava (2010) also contends that GMOs have caused multiple deleterious effects, none of which have been substantiated by any credible scientific evidence.

Bhargava's assertion that the yields from organic cultivation are comparable to the yields obtained using Bt plants (Bhargava, 2010) does not fit the empirical data. Contrary to his assertion,

## Bt-brinjal is an important tool for the control of fruit and shoot borer

A response to the article by Pushpa M. Bhargava in *Microbiology Today*, August 2010 (pp. 174–177).

the excellent performance of Bt-cotton has made India the second largest exporter of cotton (Chaudhary & Gaur, 2010).

Bhargava insists that the GEAC should have 25 tests done on Bt-brinjal. The GEAC's Expert Committee critically reviewed those 25 tests in 2009 and considered only five of them relevant to the Bt-brinjal issue, which had already been conducted. Bhargava later raised the bar to 30 tests (Bhargava, 2010). None of his proposed safety tests appear to have anything to do with assuring the safety of Bt-brinjal.

India is not the origin of brinjal, but is the centre of its diversity and, except in the eyes of activists, there is no reason why a genetically engineered crop cannot be grown in the country that is the centre of its origin or diversity, as exemplified by maize in Mexico.

Bhargava (2010) objects to the presence of antibiotic resistance gene markers in Bt-brinjal. These markers pose no threat (Ramessar *et al.*, 2007); the European Food Safety Authority concluded that the lateral transfer of antibiotic marker genes to bacteria is unlikely and has not been demonstrated either in the laboratory or in nature, where they are abundantly present in all environments. Moreover, many scientific societies, including the American Society for Microbiology, have clearly endorsed the safety of the antibiotic resistance genes as marker genes in transgenic crop development. There has been no evidence of gene flow between brinjal or *Solanum* (Kameswara

Rao, 2010). Farmers have grown these crops in neighbouring fields for centuries without a reduction in quality. If there were gene flow in brinjal, it would also happen with organic brinjal, affecting the Bt-brinjal crop in the neighbouring fields.

People certainly have a right to know what they are eating, as emphasized by Bhargava. He contends that 90% of UN member countries have strict labelling laws or do not permit transgenics for human consumption; that is not correct. Labelling a product 'contains no GM ingredients' as in the UK, is intended to exploit a market opportunity by demonizing transgenic foods. Meanwhile, more than 350 million Americans have been safely consuming transgenic foods for more than 14 years, constituting the largest human experiment on the safety of genetically engineered foods.

Also, Bhargava's fears about the enhanced toxicity of Bt-brinjal are scientifically unfounded; GM foods now have a long history of safe consumption and there is no evidence of any transgenic food being more toxic than its non-transgenic counterpart. Furthermore, transgenic crops have not been projected as the only way to meet food requirements in the future. They are regarded as a major tool for securing sustainable food production in the coming years. Transgenics help in preventing the current enormous pre-harvest losses, enhancing product recovery. They are not projected as high-yielding alternatives since there are no

transgenes that increase yield per se. Green revolution practices have reached a plateau and current agricultural practices, including organic farming, cannot match the potential of transgenic technology in ensuring higher crop productivity or recovery.

On the issue of the Bt-brinjal moratorium, Bhargava (2010) remarked that the MoEF has the support of only two people, the Prime Minister and the President of the Congress Party; that in itself is overwhelming evidence that the majority of the Government of India does not share the MoEF's reservations about the efficacy, safety and need for Bt-brinjal.

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## In reply

In response to the letter of Kameswara Rao, Shantharam & Moses, Pushpa Bhargava makes the following points.

**MAHYCO**, the Indian company referred to in the letter, has 26% of its shares owned by Monsanto, and according to Indian Company law, has the veto right on the board. Furthermore, the Indian Universities mentioned have been supported by sources with a vested interest in developing Bt-brinjal.

The recommendation of the commercial release of Bt-brinjal by GEAC on the basis of a report of the Expert Committee was criticized widely as members of GEAC had little time to examine it; it was subsequently found to be scientifically deficient on most counts (see PDF resource at [www.sgm.ac.uk/pubs/micro\\_today/current.cfm](http://www.sgm.ac.uk/pubs/micro_today/current.cfm)).

To state that the moratorium was based on political expediency is absurd. The Minister instigated the moratorium in spite of political favour. More than a dozen States, representing all major political parties, stated that they will not permit Bt-brinjal; this cannot be called political expediency. It is also totally incorrect to say that, in the public consultation process, opportunities were not provided to the scientific community to express their opinion. I attended one of the consultations and there were a large number of scientists who also spoke. Those who supported the release of Bt-brinjal had nothing to say publicly in their defence.

It is also not true that the brinjal farmers suffer 50–70% loss due to pest infestation. Furthermore, my assertion that yields from organic cultivation are not lower than yields obtained with Bt plants is based on data which are readily available and have been verified by the Government repeatedly.

While there is no doubt that Bt-cotton has performed well in

some areas, it has not performed well in all areas. In Punjab, there is an increase in the incidence of attack by mealy bugs. In Gujarat, the pests that are attacking Bt-cotton are resistant to the Bt gene, a fact conceded by Monsanto itself. With regard to the adverse effects of GMOs, Jeffrey Smith's Book '*Genetic Roulette*' documents the health risks of genetically engineered food with over 1,000 references. What is concerning is that the supporters of GM crops doubt the credibility of every study on the possible or proven adverse effects of GMOs, whilst accepting every study supporting GM crops, regardless of their scientific quality.

There are sound scientific reasons as to why a GM crop should not be grown in the country that is the centre of its origin. There is an internationally accepted covenant to this effect. Growing maize in Mexico is a good example. This was done surreptitiously and was criticized by scientists the world over. That antibiotic resistance markers do not pose any threat is not true – there are many references to this effect in the literature. Today, we have technologies for developing GM varieties that do not use antibiotic resistance markers. Why were these technologies not used for Bt-brinjal?

### PUSHPA M. BHARGAVA

Nominee of the Supreme Court of India on the Genetic Engineering Appraisal Committee of the Government of India; Former and Founder Director, Centre for Cellular and Molecular Biology, Hyderabad; Former CSIR Distinguished Fellow; Former Vice-Chairman, National Knowledge Commission, Government of India; Former Member, National Security Advisory Board, Government of India



## Tuberculosis –

Tuberculosis, caused by *Mycobacterium tuberculosis*, kills over a million people each year and causes prolonged illness in many millions more. Although it can be treated using prolonged therapy with cheap drugs, resistant strains of the bacterium are spreading. New antibiotics that attack new targets in the bacterium are therefore needed. The genome of *M. tuberculosis* has been sequenced and biochemical processes that are essential for the bacterium but absent from its animal hosts, including people, have been identified. One of these is the biosynthesis of branched-chain amino acids. Indeed, *M. tuberculosis* strains that cannot synthesize branched-chain amino acids cannot grow inside animals. This is much too good an opportunity to miss in trying to develop new antibiotics.

The first step in branched-chain amino acid biosynthesis requires an acetohydroxyacid synthetase (AHAS) enzyme. Searching through the genome sequence and the scientific literature, the researchers identified genes for four AHAS catalytic subunits and one regulatory subunit, the level of redundancy matching the importance of AHAS activity to *M. tuberculosis*. However, only one of these had ever been reported to produce an active protein. The researchers therefore made a systematic effort to obtain protein from all five genes by inserting them into *Escherichia coli*. This is a very well-known technique involving commercial strains of *E. coli* that have been optimized to produce foreign proteins. The group also developed a test for

## a step forward

activity of each of the AHAS genes that they could perform on *M. tuberculosis* cells from different environments. The objectives were therefore to discover the basic biochemical properties of the proteins and also see if *M. tuberculosis* was likely to use any of the genes in specific environments.

They found that all the genes were active under some conditions. Two (*ilvG* and *ilvB2*) assumed particular importance in immune cells of infected animals, and at low oxygen levels or acidic pH. The overall profile suggested that these two genes have a role in energy provision for the cells rather than in amino acid biosynthesis. Once the researchers had obtained the pure proteins, only two of the subunits showed any enzyme activity. The complex

Singh, V., Chandra, D., Srivastava, B.S. & Srivastava, R. (2011). Biochemical and transcription analysis of acetohydroxyacid synthase isoforms in *Mycobacterium tuberculosis* identifies these enzymes as potential targets for drug development. *Microbiology* 157, 29–37.

process of protein synthesis means that there can be many reasons for this, other than the proteins really being inactive. The kinetic parameters of the two proteins showed several differences from previously studied AHAS enzymes – a tantalizing inducement to the researchers to continue their efforts to obtain pure, active protein from all AHAS genes. This study marks a step forward in developing new anti-tuberculosis drugs.



Ticks.  
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## Novel Lyme

Lyme borreliosis is a multi-system disorder and the most common infectious arthropod-borne disease in Europe and the United States. The disease is induced by a spiral unicellular Gram-negative bacterium of the *Borrelia burgdorferi sensu lato* complex that is transmitted by hard-bodied ticks (Ixodidae) throughout the temperate zones of the northern hemisphere. A large number of *Borrelia* isolates have been obtained from various vertebrate species, including humans. At present, 18 species

of *B. burgdorferi sensu lato* are recognized around the world.

In a recent study of strains isolated from ear biopsies of cotton mice (*Peromyscus gossypinus*) and the Florida or Eastern woodrat (*Neotoma*

## Rabbitpox vs smallpox

Smallpox is the only disease of humans that has ever been eradicated. On average, it killed a third of the people it infected, and left those that recovered with scars from its characteristic pocks. Even at the start of the 1960s, it killed around 2 million people each year worldwide. It only infected humans, and this feature made eradication possible through a combination of vaccination and public health measures. By 1980, no cases were being reported, even from remote areas of the world, and the only risks remained from virus samples held in laboratories, and now by the military in the USA and Russia. The orthopoxvirus variola virus

Nalca, A. & Nichols, D.K. (2011). Rabbitpox: a model of airborne transmission of smallpox. *J Gen Virol* 92, 31–35.

## disease species

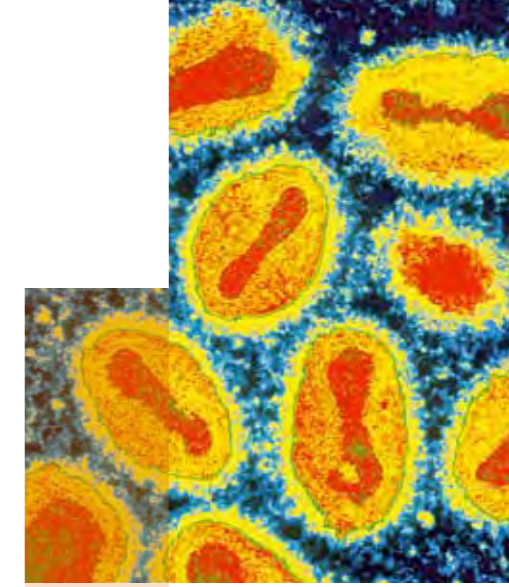
*floridana*) from five woodland localities in South Carolina, USA, all the strains certainly had the general characteristics of the genus *Borrelia* but differed in some genotypic details. The researchers examined a wide range of gene sequences in order to characterize the bacteria. The results of the multilocus sequence analysis showed that the 15 isolates were very similar to each other but differed sufficiently from all recognized species to constitute a novel species in the *B. burgdorferi sensu lato* complex.

The two above-mentioned small mammals are the primary hosts of this novel species, named *Borrelia carolinensis* in recognition of its geographical origin.

Rudenko, N., Golovchenko, M., Grubhoffer, L. & Oliver, L.H., Jr (2011). *Borrelia carolinensis* sp. nov., a novel species of the *Borrelia burgdorferi sensu lato* complex isolated from rodents and a tick from the south-eastern USA. *Int J Syst Evol Microbiol* 61, 381–383.

(VARV) that had killed so many people was essentially extinct. When smallpox

was eradicated, there were very few medical treatments available for patients, and the vaccine was effective in the pre-HIV/AIDS world. Until now, there has been no perceived need to continue working on improving treatments which would certainly have been possible due to advances in our knowledge of virus biology. However, these advances also mean that it is now perfectly possible to synthesize the genome of VARV and use it to restart the infection cycle. There is concern in the USA that it might be used in bioterrorism. Aysegül Nalca and Donald Nichols have been considering a fundamental problem in starting work again on smallpox, namely what animal to use instead of humans?



Smallpox virus particles. Eye of Science / Science Photo Library

All the animals that have been used in the past required the infection to start either after an injection of the virus or from inhaling very large numbers of VARV particles. However, one of the characteristics of smallpox was that it could be transmitted as an aerosol and less than 100 virus particles were needed to start an infection in a person.

The disease rabbitpox is caused by another large, double-stranded virus from the orthopoxviruses (RPXV), and the researchers make the case for it to be the ideal replacement for study. Its DNA sequence turns out to be very similar to vaccinia virus, the virus used in developing effective anti-smallpox vaccines. Some researchers think RPXV could be a strain of vaccinia virus, although it has three extra genes that are involved with virulence.

Rabbitpox is an interesting disease in its own right. It occurs in laboratory colonies, but not in wild rabbits. The first record of this disease, from the Rockefeller Institute in 1930–33, killed about half the rabbits and was very contagious. The symptoms were similar to those of smallpox. A less lethal version broke out in Utrecht in 1941, and all subsequent outbreaks have been of this version, although none have occurred since the 1960s.

The disease is spread rapidly amongst rabbits as an aerosol. There is a spectrum of symptoms, partly depending on the amount of virus particles that start the infection, and this matches the range of smallpox symptoms in people. One difference is that rabbitpox damages the lungs, which did not happen with smallpox. Since developing improved treatments is a priority, the two scientists were very pleased that the drug ST-246 (SIGA), effective against many orthopoxviruses, also protected rabbits against lethal levels of RPXV aerosols. In addition, an anti-smallpox vaccine protected all the rabbits in a test group from RPXV aerosols. From this evaluation, the researchers are sure that rabbits and rabbitpox can teach us about new ways to protect ourselves from any re-emergence of smallpox.



## 'Q' the fever

Q fever is a disease caused by *Coxiella burnetii*, a Gram-negative bacterial species with a very unusual life history. The reasons for interest in it, apart from its interesting biology, are that it causes an important disease of livestock and a disease in humans that has been investigated for its biological warfare potential. Two recent scientific developments have finally started to open up understanding of *C. burnetii*. Until 2009, it was impossible to grow *C. burnetii* outside living cells, but a complex synthetic medium has now been identified. In addition, one isogenic mutant has been made, which should start to improve understanding of how it interacts with its host cells. This recent review is therefore a very timely reminder of the current state of knowledge of this strange bacterium.

Unlike most bacteria, *C. burnetii* is an obligate intracellular parasite, although it can survive in an infective form in animal tissues and fluids in the environment. Indeed, it is surprisingly difficult to decontaminate an area infected with *C. burnetii*. Its cells have several forms, but the relationship between them is not really understood.

The consequences of an infection range from no apparent symptoms to fever, pneumonia and death, although other symptoms, including chronic fatigue or endocarditis, can appear years after the infection starts. Domestic animals can be infected, but are symptomless and shed vast quantities of the bacterium into milk, faeces and urine.

Oyston, P.C.F. & Davies, C. (2011). Q fever: the neglected biothreat agent. *J Med Microbiol* 60, 9–21.

Infection in ruminants can have the consequence of spontaneous abortion and infertility. People are usually infected from inhaling aerosols generated by animals or from consumption of dairy products. An outbreak of Q fever in the Netherlands that started in 2007 with the consequence of waves of spontaneous abortions in dairy goats and sheep has so far caused over 3,763 cases in humans, including 11 deaths, despite increasingly stringent measures to curtail its spread.

Q fever has been used in biological weapons programmes by both the USA and former Soviet Union. The attraction is that an aerosol can cause an incapacitating pneumonia from fewer than 10 particles. Although relatively few people will die, a substantial number will be incapacitated due to illness. Experiments in the USA with conscientious objectors in 1955 identified very clearly the low level of an infectious dose, as well as the incubation period and symptoms. However, the difficulty in growing enough of the bacterium to use as a weapon, as well as the difficulty that there could be in regaining control of the situation, as seen from the continuing public health problem from the recent natural outbreak in the Netherlands, mean that there are several practical drawbacks to Q fever within a military setting. The answers to even simple questions about what cleaning methods should be used to ensure surfaces are not contaminated are not really known.

Right from its initial discovery, Q fever has continued to surprise scientists and looks like it will continue to do so well into the future.

## SGM journals in the news

The end of 2010 and beginning of 2011 saw a good amount of press coverage for the SGM's four journals, in particular *Microbiology* and *Journal of Medical Microbiology*.

A media release promoting the *Microbiology* paper 'Recombinant lactobacilli expressing linoleic acid isomerase can modulate the fatty acid composition of host adipose tissue in mice' was sent out just before Christmas. The release, entitled *Designer probiotics could reduce obesity*, generated articles in the *Daily Express*, *Irish Examiner* as well as the *Telegraph* – who held off printing their story until early January, presumably to pique the interest of those trying to combat the excesses of Christmas!

A second wave of interest in early January in the novel bacterial species found aboard the *Titanic* saw more coverage for *IJSEM* throughout news outlets in Australia, the US and Argentina (see article on p. 3).

A paper in *Journal of Medical Microbiology*, describing the effectiveness of cold plasma jets at treating multi-drug resistant infections, highlighted a slightly more unusual solution to the problem of antibiotic resistance. The story was a hit in popular science magazines in the US and Australia.

All press releases can be viewed on our website at [www.sgm.ac.uk/news/media\\_releases.cfm](http://www.sgm.ac.uk/news/media_releases.cfm)

**LAURA UDAKIS**



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## Emerging Infections 9

Editors W.M. Scheld, M.L. Grayson & J.M. Hughes

Publisher American Society for Microbiology (2010)

Details US\$154.95 | pp. 406  
ISBN 978-1-55581-525-7

Reviewer Alain Kohl  
University of Edinburgh

New and re-appearing parasitic, fungal, bacterial and viral diseases, commonly termed emerging and re-emerging infections, have long been recognized as major problems in human and veterinary medicine. Considerable research efforts are focussed on understanding the manifestations and processes behind emerging infections. It is therefore not surprising that this is now the 9th volume of the *Emerging Infections* series, which is born out of sessions on new and emerging pathogens of the IDSA and ICAAC annual meetings. In 18 chapters written by experts in their respective areas of research, this book addresses a wide range of issues, covering clinical aspects, epidemiology and disease symptoms, but more general concepts and novel ideas are also addressed. *Emerging Infections 9* is therefore not just of interest to clinicians and others involved in public and veterinary health, but provides a very good overview of recent developments to those working on emerging pathogens or those simply interested in the subject, including students. Not surprisingly, given its global impact, a case study for H1N1 influenza is included, but other chapters dealing with various viral (Hepatitis E, HTLV-1, novel

arenavirus infections, HIV-associated malignancies) as well as bacterial (drug-resistant bacilli, *Arcobacter*, buruli ulcer) and parasitic (*Plasmodium knowlesi* and neglected tropical diseases) infections provide interesting reading. Of particular interest are chapters on the role of cytomegalovirus in transplantation and the challenging hypotheses on the role of giant viruses of algae (mimivirus) in pneumonia.

More general chapters deal with infections in long-term care facilities (of increasing importance in Western society) and diseases associated with travel and migration, including the transport of animals. The concept of 'One World–One Health' is explained in a separate chapter which emphasizes the importance of interspecies transmission of pathogens and distribution of disease vectors; this is of increasing importance to Europe and is a must-read to everyone new to the subject for its overall relevance.

Interestingly, emerging infectious diseases of plants are described extensively in the final chapter and, although few plant biologists would purchase the book for this alone, it makes for very interesting reading to those less familiar with the subject.

This book is highly recommended to anyone interested in keeping up to date with developments in this area of research, but contains enough information to appeal to newcomers.

## The Picornaviruses

Editors E. Ehrenfeld, E. Domingo & R.P. Roos

Publisher American Society for Microbiology (2010)

Details US\$229.95 | pp. 534 | ISBN 978-1-55581-603-2

Reviewer Ulrich Desselberger, Cambridge



This book updates the comprehensive overview of picornavirus research by Semler & Wimmer published in 2002. It brings together an amazingly wide spectrum of recent work on the molecular biology, evolution and pathogenesis of this large family of viruses.

A full review is available on the website at [www.sgm.ac.uk/pubs/micro\\_today/reviews.cfm](http://www.sgm.ac.uk/pubs/micro_today/reviews.cfm), but suffice to



say that most of the worldwide leading research groups working on picornaviruses are represented. The depth and diversity of the new data are astounding. The book is highly recommended as an excellent companion for specialist

virologists, molecular biologists, cell biologists, immunologists, vaccinologists and infectious disease physicians. It should have a firm place in university and departmental libraries, serving students carrying out relevant biomedical research.

## Viruses, Plagues, and History: Past, Present, and Future

**Author** M.B.A. Oldstone

**Publisher** Oxford University Press, Inc. (2009)

**Details** US\$17.95 | pp. 383 | ISBN 978-0-19532-731-1

**Reviewer** Janet Hurst, *Goring-on-Thames, Oxfordshire*

A huge amount of information is packed into just under 350 pages in this book (plus references and index), yet it is written in a very readable style. The author, a distinguished viral immunologist, tells the story of the big impact of virus diseases on communities and world history, how scientists discovered the causative agents and developed methods of control, and laments how human folly and politics have often hindered progress in combating these plagues.

To set the scene, the first two chapters cover the principles of virology and the principles of immunology. Readers who are virologists can skip this section and move straight to the success stories. Oldstone chooses smallpox (the only human disease to have been eradicated by vaccination), yellow fever, measles and poliomyelitis as examples of viruses harnessed by innovations of health care and political will. He then moves on to present and future challenges with chapters on haemorrhagic fevers, Lassa fever, Ebola, Hantavirus, SARS, West Nile virus and, of course, HIV. He considers influenza, a disease that seemed to be fairly well under control, but now poses new threats as dangerous strains of the virus arise. At the time of writing, Bird flu was in the news, but swine flu had not yet emerged, neatly showing that the author's opinions are correct. Oldstone includes prions with viruses and there is a chapter on spongiform encephalopathies, which contains a succinct but thorough history of mad cow disease in the UK and the conflicts that arose between business interests, government policy and public health professionals.

The final chapter looks to the future and the author praises the scientists who dedicate their lives to research on viruses, on whom we shall rely to save us from the plagues to come.

As seems inevitable in paperback editions of books of this kind, the illustrations are sparse and their reproduction is poor. This apart, it is an excellent and thought-provoking book, and a good 'one-stop shop' for its subject area.

## Reviews on the web

Reviews of the following books are available on the website at [www.sgm.ac.uk/pubs/micro\\_today/reviews.cfm](http://www.sgm.ac.uk/pubs/micro_today/reviews.cfm)

### AIDS and Tuberculosis: A Deadly Liaison

**Editors** S.H.E. Kaufmann & B.D. Walker  
**Publisher** John Wiley & Sons Ltd (2009)  
ISBN 978-3-52732-270-1

### Principles of Translational Science in Medicine

**Editor** M. Wehling  
**Publisher** Cambridge University Press (2010)  
ISBN 978-0-52188-869-1

### Coral Reefs in the Microbial Seas

**Authors** F. Rohwer & M. Yoyle  
**Publisher** Plaid Press (2010)  
ISBN 978-0-98270-120-1

### Molecular Phylogeny of Microorganisms

**Editors** A. Oren & R. Thane Papke  
**Publisher** Caister Academic Press (2010)  
ISBN 978-1-90445-567-7

### The Immortal Life of Henrietta Lacks

**Author** R. Skloot  
**Publisher** Pan MacMillan (2010)  
ISBN 978-0-23074-869-9

### Biodata Mining and Visualization: Novel Approaches

**Author** I. Havukkala  
**Publisher** World Scientific Publishing (UK) Ltd (2010)  
ISBN 978-9-81279-036-1

### Helicobacter pylori in the 21st Century

**Editors** P. Sutton & H.M. Mitchell  
**Publisher** CAB International (2010)  
ISBN 978-1-84593-594-8

### Clostridium difficile: Methods and Protocols

**Editors** P. Mullany & A.P. Roberts  
**Publisher** Humana Press (2010)  
ISBN 978-1-60327-364-0

### Iron Uptake and Homeostasis in Microorganisms

**Editors** P. Cornelis & S.C. Andrews  
**Publisher** Caister Academic Press (2010)  
ISBN 978-1-90445-565-3

### Bifidobacteria: Genomics and Molecular Aspects

**Editors** B. Mayo & D. van Sinderen  
**Publisher** Caister Academic Press (2010)  
ISBN 978-1-90445-568-4

### Bacteriophages in the Control of Food and Waterborne Pathogens

**Editors** P.M. Sabour & M.W. Griffiths  
**Publisher** American Society for Microbiology (2010)  
ISBN 978-1-55581-502-8

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**CARBAPENEMASES**

(carbapenem-hydrolysing  $\beta$ -lactamases) matter because carbapenems are often the last 'good' antibiotics for infections due to multi-resistant, Gram-negative opportunists. Several carbapenemases are already circulating: one, KPC, has disseminated in the USA, Israel and Greece; another, VIM, is widespread among *Klebsiella* in Greece. These have been imported into the UK and there is some domestic spread of KPC in north-west England.

The first isolates with the new NDM enzyme – *E. coli* and *K. pneumoniae* – were collected in Sweden in 2008 from a patient transferred a day earlier from New Delhi. As a metallo- $\beta$ -lactamase, it was named after the source city, 'New Delhi Metallo.' By mid-2008, the UK Health Protection Agency was seeing NDM too, with 37 isolates from 29 patients and 25 hospitals by December 2009. Strikingly, 17 patients had travelled to India or Pakistan and 14 had been hospitalized there. This prompted action. First, we collaborated with Tim Walsh and colleagues at the University of Wales, Cardiff, who were involved in the original discovery. Second, we enabled groups across India and Pakistan to seek the *bla*<sub>NDM</sub> gene by PCR. Third, in July 2009, we sent a 'National Resistance Alert' to UK clinical microbiologists warning of NDM-1 and its link to the subcontinent.

In spring 2010, a Mumbai group published on 22 cases infected with NDM-1 *Enterobacteriaceae* and the US CDC reported 3 cases, all previously hospitalized in India. This passed quietly. Then, in August, *Lancet Infectious Diseases* published our study showing dissemination in India and repeated import to the UK (Kumarasamy *et al.*, 2010; *Lancet Infect Dis* 10, 597–602), and my job changed. We had TV from China, Japan, Brazil, Europe, Canada and India, and tried to explain that 'NDM itself isn't a superbug, but it makes a superbug' and 'the bacterium carries the plasmid that carries the gene that encodes the enzyme that eats the antibiotic'.

Back to microbiology. The earliest NDM-1 producers date from 2006 in New Delhi. NDM-1 has now been reported from Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hong Kong, Israel, Japan, Kenya, Norway, The Netherlands, Oman, Singapore, Slovenia, Sweden and Taiwan, as well as the UK and the USA, with many cases linking to the Indian subcontinent. Presentations vary from benign colonizations to septicaemias, with several deaths. Urinary infections are commonest. Those hospitalized in India and Pakistan include medical tourists, but also accident victims and those who divide lives and treatment between the UK and the subcontinent. *K. pneumoniae* and *E. coli* are the main hosts, but NDM occurs in other *Enterobacteriaceae* and *Acinetobacter* spp., reflecting carriage by promiscuous plasmids easily spread among genera. The common denominator is extreme multiresistance,

Metallo- $\beta$ -lactamase protein fold. Pasięka / SPL

August 2010 saw a spate of 'superbug' articles in the UK press, prompted by the NDM-1  $\beta$ -lactamase, a resistance mechanism linked to India and Pakistan. Coverage in the Indian press was extensive: some condemned the enzyme's name as a national insult; some claimed a plot to damage India's fast-growing US\$2.4 bn p.a. medical tourism industry – just google 'NDM Indian Express' for a taste!

DAVID LIVERMORE

complicating treatment. Most producers remain susceptible to colistin (rather toxic), tigecycline (unsuitable for urinary infections) and fosfomycin (only consistent against *E. coli*). No drug in clinical development is active. This isn't a pretty set of choices.

The combination of promiscuity and extreme resistance distinguishes NDM-1 from other carbapenemases. KPC enzymes are commoner but are inactivated by a new  $\beta$ -lactamase inhibitor in development (NXL104; AstraZeneca); NDM-1 isn't. The other concern is the link to India, where state-of-the-art medicine balances on unregulated antibiotic use (though this may soon change, with enforcement of prescription law), fiercely competing generics, and an overloaded infrastructure where 650 million citizens lack a flush toilet. Bacteria with cephalosporin-hydrolysing, 'extended-spectrum'  $\beta$ -lactamases circulate in the community gut flora and are acquired by tourists. It is important to know whether NDM too is circulating outside hospitals.

Such questions underscore the need for robust resistance surveillance in a world of mass travel and globalized medicine. Also vital are infection control to stop hospital spread, regulation of antibiotic use and reinvigoration of antibiotic development. Unfortunately, many pharmaceutical companies have down-graded antibiotic development, reflecting the challenges of discovery, the considerable regulatory hurdles and the poor profitability of antibiotics compared with other medicines. These challenges must be overcome, for modern medicine depends on infection being treatable. If this is lost, through resistance, we will slip back to the situation of three brief generations ago when the infection risk would have made many procedures unthinkable.

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

COMMENT

NDM-1 superbug: harbinger or hype?