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Cover image The typhus louse shaking hands with Death. A Russian poster from 1919 warning of the danger of typhus. *Wellcome Library, London*

Editor Dr Matt Hutchings Editorial Board Dr Sue Assinder, Professor Iain Hagan, Professor Bert Rima Managing Editor Janet Hurst Assistant Editor Faye Stokes Design & Production Ian Atherton Contributions are always welcome and should be addressed to the Editor c/o SGM Headquarters, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG Tel. 0118 988 1809 Fax 0118 988 5656 email mtoday@sgm.ac.uk web www.sgm.ac.uk Advertising David Lancaster, McMillan-Scott PLC, London Office, 10 Savoy Street, London WC2E 7HR Tel. 0207 878 2316 Fax 0207 379 7118 email david@mcmslondon.co.uk Regular feature images pp. 3 *SGM*; 29 *Imperial College London/SPL*; 31 *Mauro Fermariello/SPL*; 35, 37 *Stockbyte*; 39 *Simon Lewis/SPL*; 41 *Digital Vision*; 43 *Tek Image/SPL*; 45 *Photodisc*

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Have your say

In this issue we introduce a new Letters & Opinion section to *Microbiology Today*. From time to time articles published in *MT* cause some debate amongst the microbiology community and people often ask the editorial office if they can write responses to those articles.

Now, we're all in favour of reasoned debate. so it seemed only fair that we introduce a section in which you, our readers, can offer an alternative point of view. We are also inviting comments on just about anything else you read in MT, anything you'd like to see covered in the magazine and any interesting developments or news stories which we somehow missed.

The SGM, and this magazine, are here to represent all the members so we're relying on your feedback to keep this section alive and interesting. As a start, you can read about the reaction to some of the opinions on the recent Systematics issue on p. 44.

***Matt Hutchings**, Editor*

Staff News

Welcome to new Staff Editor **Nicolas Fanget**, who is initially training on *JGV*. Nicolas is just completing his PhD at Napier University where he has been researching the starvation survival of *Rhodococcus*.

HEA subject review of microbiology and biochemistry

In 2007, the Higher Education Academy (HEA) Subject Centre for Bioscience will be conducting a major review of the student experience in microbiology and biochemistry in UK higher education. This is one of three pilot reviews commissioned by the HEA, with the intention of expanding the scheme in subsequent years. The review will be managed by two Review Panels consisting of representatives from academia, employers, students and learned societies. Sue Assinder (SGM Education Officer) has been invited to chair the Microbiology Panel, with Keith Elliott (Manchester University) taking the lead for the Biochemistry review. The SGM is formally supporting the project and Janet Hurst will sit on the Microbiology Panel to represent the various microbiology learned societies.

The Review will consider factors relevant to students' learning, from pre-entry, through to provision at undergraduate and postgraduate level, and to issues relating to graduate destination and employment. It will make use of quantitative data for all universities where this is available (e.g. centrally published by funding councils and the results of the National Student Survey). Where new data are required, the review will select a subset of universities, paying attention to the different admission and teaching arrangements in Scotland. Learned Societies will also have useful data collected from their subject communities, including employer needs and satisfaction with regard to the subject area. The SGM has a 'representative' in all of the appropriate departments in the UK and these individuals will be a very important source of information.

The principal output from the review will be a report providing an evidence-based overview of the context and state of HE provision for microbiology. This will summarize the range of learning experiences available and highlight issues of concern, giving departments information from which to reflect on the appropriateness of their own courses.

***Sue Assinder**, Education Officer*

News of members

Royal Society

Congratulations to Council Member **Professor Lorna Casselton** on her election as Foreign Secretary and Vice-President of the Royal Society.

Deaths

The Society notes with regret the deaths of **Professor William. T. Coakley** (member since 1980; see obituary on website), **Dr Tom H. Flewett** (member since 1950), **Dr Stanley Jackson** (member since 1954) and **Dr Maurice Jones-Mortimer** (member since 1968).

New Year's Honours 2007

Congratulations to the following on their awards:

Knight Bachelor

Howard Dalton FRS, Chief Scientific Adviser to Defra and Professor of Biological Sciences, University of Warwick (SGM President 1997–2000 and Honorary Member).

CBE

Donald James Jeffries, Professor of Virology and Head, Department of Medical Microbiology, St Bartholomew's and Royal London, for services to medicine.

OBE

Professor Susanne Moira Brown, Director and Chief Scientist, Crusade Laboratories, for services to health care.

SGM Council

Nominations 2007

Three members, **Professors Lorna Casselton**, **Iain Hagan** and **Nick Mann**, retire from Council in September 2007. Nominations are invited from Ordinary Members to fill these vacancies. All nominations must include the written consent of the nominee and the names of the proposer and seconder, both of whom must be Ordinary Members. Members submitting nominations should indicate the main area of microbiological interest of their nominee, who must have been a member of the Society for at least 2 years. Nominations should be sent to the SGM General Secretary, Dr Ulrich Desselberger, c/o SGM HQ to arrive no later than **30 April 2007**.

November Meeting Highlights

New President

Council members welcomed **Robin Weiss PhD FRCPath FRS**, Professor of Viral Oncology, University College London, London, to his first session as the new SGM President.

Honorary Membership

Council was pleased to confer Honorary Membership on **T. Hugh Pennington MB BS PhD**, Professor Emeritus, University of Aberdeen and SGM President 2003–2006.

SGM Prizes 2007

Council approved the following awards:

The Fleming Lecture to **Professor Gregory Challis**, University of Warwick, for outstanding work on the functions of predicted gene clusters of *Streptomyces coelicolor* ('genome mining'), leading to the discovery of novel mechanisms of the biosynthesis of antibiotics and other metabolic pathways.

The Fred Griffith Review Lecture to **Professor E. Richard Moxon**, Oxford University Department of Paediatrics, for excellence in the study of genomics and postgenomics of *Haemophilus influenzae* and *Neisseria meningitidis*, and for major contributions to the rational development and clinical study of safe and effective vaccines against these and other micro-organisms.

The Colworth Prize Lecture to **Professor Paul Williams**, University of Nottingham, for his groundbreaking work on the molecular mechanisms of cooperative bacterial social behaviour ('quorum sensing') and for numerous applications of his basic research work in biotechnology, agriculture, ecology and medicine.

The Peter Wildy Prize for Microbiology Education to **Professor Simon Cutting**, Royal Holloway, University of London, for the development of an extensive and productive programme of educational courses in Vietnam.

A more detailed appreciaton of the prizewinners' work will appear elsewhere in *Microbiology Today*. The lectures will be delivered at SGM meetings in 2007.

Strategy meetings

The President announced that he was convening a meeting in March to discuss SGM strategy. The Scientific Meetings Officer, **Professor Hilary Lappin-Scott**, gained Council approval to carry out a review of SGM meetings and group structure in 2007. Comments on any issues relevant to Society activities are welcome.

Interaction with other learned societies

Ms Ruth Cooper of the Royal Society presented an update on the International Scientific Unions Committee of the Royal Society and outlined possibilities for interaction with SGM.

***Ulrich Desselberger**, General Secretary*

BioSciences Federation Communication Prize

The 2006 prize was awarded to **Dr Chris Smith** for his extensive work communicating microbiology and other scientific research to the public. Chris is a doctor and a scientist and his current role is as clinical lecturer and specialist registrar in virology at Cambridge University. Chris started *The Naked Scientists Radio Show*, which began on local radio, but now reaches huge audiences worldwide, and he is also at the forefront of podcasting. Check out **www.thenakedscientists.com**

Chris was joint winner of the Promega Prize at the SGM meeting in Exeter in 2000. You read about his radio career first here in *Microbiology Today*! In February 2001 Chris described his first show, *ScienceWorld*, which was broadcast from Cambridge on Sunday evenings.

Prize lectureships

Colworth Prize Lecturer

Professor Paul Williams will deliver his prize lecture, entitled *Look who's talking: communication and co-operation in the bacterial world*, on Wednesday, 28 March 2007 at the Society's meeting at the University of Manchester. The Colworth Prize Lecture is awarded for an outstanding contribution of importance in applied microbiology.

Paul is currently Professor of Molecular Microbiology in the School of Molecular Medical Sciences and Director of the Institute of Infection, Immunity & Inflammation at the University of Nottingham. He graduated in Pharmacy at Nottingham in 1979 and did a PhD in microbiology with Mike Brown at the University of Aston in Birmingham. After a short postdoc at Aston, he moved back to Nottingham in 1985 as a lecturer in the department of Pharmaceutical Sciences and was promoted to Professor in 1995. Paul's research interests primarily focused on the molecular basis of bacterial pathogenicity, but a chance observation in the early 1990s redirected his focus to the study of cell-to-cell communication (quorum sensing) in diverse bacteria of biotechnological, agricultural and medical importance. This work, in collaboration with colleagues in the UK and overseas, has resulted in the discovery of new signalling molecules and communication strategies not just between bacteria, but between bacteria and higher organisms. Consequently, this has created new opportunities for developing novel therapeutics and in particular antibacterial and immune modulatory agents.

Fleming Lecturer

Professor Gregory Challis will deliver his prize lecture, entitled *Mining microbial genomes for new natural products and biosynthetic pathways*, on Tuesday, 27 March 2007 at the Society's meeting at the University of Manchester. The Fleming Lecture is awarded for outstanding research by a microbiologist in the early stages of their career.

Greg Challis obtained a BSc in Chemistry from Imperial College London and a DPhil in Organic Chemistry at the University of Oxford. In 1998 he was awarded a Wellcome Trust International Prize Travelling Research Fellowship to undertake postdoctoral research in the Department of Chemistry at Johns Hopkins University in Baltimore, USA. He returned to England in 2000 to carry out postdoctoral research on the same fellowship in the *Streptomyces* group at the John Innes Centre in Colney, Norwich. The following year he was appointed as Lecturer in Chemical Biology in the Department of Chemistry at the University of Warwick and began his independent research programme at the interface of chemistry and microbiology.

In 2003 he was promoted to Senior Lecturer and in 2006 he was promoted to his current position of Professor of Chemical Biology. Greg was the recipient of the 2002 Meldola Medal and Prize of the Royal Society of Chemistry.

Grants

Grants schemes reviewed

As described in the last issue of *MT* (p. 146), SGM grant schemes have been reviewed. The new rules have been in force since 1 January 2007. Check the website to ensure that you are applying for the right grant on the correct form!

Travel and meetings

Postgraduate Student Conference Grants

All postgraduate student members are eligible to apply for a grant to support their attendance at one SGM meeting each year. Grants cover 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 Student Members resident and registered for a higher degree in an EU country. Closing date for Manchester meeting: **23 March 2007**.

Technician Meeting Grants

All technician members are eligible to apply for a grant to support their attendance at one SGM meeting each year. Applicants need not be presenting work at the meeting. Some microbiology technicians who are not members of SGM may also apply for grant to attend a Society Meeting. Closing date for Manchester meeting: **23 March 2007**.

Retired Member Grants

Cover accommodation and the Society Dinner at one SGM meeting a year. Closing date for Manchester meeting: **23 March 2007**.

Scientific Meetings Travel Grants

Council has introduced this new, enhanced travel grant scheme to support early-career microbiologists wishing to present work at a scientific meeting in the UK or overseas. Eligibility has been extended to include graduate research assistants and lecturers (within 3 years of first appointment in both cases) in addition to postdoctoral researchers (within 3 years of first appointment) and postgraduate students. Retrospective applications are not considered.

President's Fund for Research Visits

Council has reviewed the provision of grants to support short international research visits. Up to £3,000 is now available to support early-career microbiologists who are planning a short research visit to another laboratory (minimum visit 4 weeks, maximum visit 3 months). Closing dates for applications: **23 March** and **21 September 2007**.

SfAM/SGM Short Regional Meeting Grants

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

Studentships

Elective Grants

Funding for medical/dental/veterinary students to work on microbiological projects in their elective periods. Closing dates for 2007: **23 March** and **21 September**.

Vacation Studentships

To enable undergraduates to work on microbiological research projects for 6–8 weeks in the summer vacation before their final year. Applications must be from SGM members on behalf of named students. Closing date: **16 February 2007**.

Education and 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. Up to £1,000 is also available to support science promotion activities.

GRADSchool Grants

Postgraduate Student members who are not eligible for a free place on a UKGrad (www.grad.ac.uk) personal development course may now apply for a grant from SGM to cover full course fees. Retrospective applications not considered.

Seminar Speakers Fund

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

Student Society Sponsored Lectures

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

International

UNESCO-IUMS-SGM Fellowships

These provide funding for young microbiologists from developing countries to pursue, or complete, part of an on-going research programme in a laboratory in a developed country and/or acquire theoretical or technical knowledge in their particular area of research. Council recently agreed to increase support for this scheme, so that SGM is now funding three fellowships instead of two. See **www.iums.org/outreach/outreach-fellowships.htm** for details.

International Development Fund

The Fund exists to provide training courses, publications and other help to microbiologists in developing countries. The following award has been made for 2006.

Dr Sanjiv Rughooputh, *University of Westminster* – up to £2,500 to help support the delivery of a molecular biology training course in Mauritius.

Applications for 2007 are invited. Closing date: **21 September 2007**.

International Research Grants

This scheme has now been discontinued.

The following awards have been made for 2006.

Prof Edward Jarrol, *North Eastern University, Boston* – up to £2,550 to visit Birkbeck College to study carbohydrate analysis of *Balamuthia mandrillaris* trophozoites and cysts.

Dr Judith Hall, *University of Newcastle* – up to £2,510 contribution to visit James Cook University, Australia to look at whether antimicrobial peptides function as part of the Cnidarian defence mechanism against microbial infection.

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. Closing date:**21 September 2007**.

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

Microbes shaping history

Distinguished science writer **Bernard Dixon** reflects on the past, present and future effects of microbes on our world.

Some time in 1845 *Phytophthora infestans* began to ravage Ireland's previously healthy potato plants – the country's staple food. A million poor folk died in the ensuing famine, and 2 million emigrated for a better life in the New World and Australia. Among those who crossed the Atlantic were two entire families – the Fitzgeralds from Kerry and the Kennedys from Wexford County. So it was that John Fitzgerald Kennedy, born in 1917, was available to become President of the United States in 1960.

The story of late blight of potatoes, recounted in this issue by Gareth Griffith (p. 12), illustrates in both general and particular the huge impact that micro-organisms have had and continue to have on human affairs. Hans Zinsser highlighted another example by giving the title '*On the comparative unimportance of generals*' to one of the chapters in his classic book *Rats, Lice and History*. He pointed out that as Napoleon's armies marched back and forth across the continent of Europe, typhus and other infections struck down far more soldiers on both sides than did the many battles in which they were involved. Gavin Thomas develops this theme on p. 8, while Milton Wainwright (p. 16) discusses the links between World War II, infectious disease and both penicillin (a microbial product) and sulphonamides.

Despite their minuscule measurements, bacteria, viruses and other forms of microscopic life have done incalculable damage and brought incalculable benefits to all other inhabitants of the biosphere. Whether in medicine, agriculture or industry; through their manifold roles in shaping the natural environment, or as a consequence of their influences on the lives and deaths of the powerful and famous, micro-organisms have been major, though usually unheralded players in the history of the world.

Perhaps the most powerful way in which micro-organisms have affected history in recent decades is through their influence on the progress of scientific research. This was already clear half a century ago when Kluyver and van Niel wrote *The Microbe's Contribution to Biology* (Harvard University Press, 1956). In contrast to its modest size, this slim volume was intellectually monumental in reviewing microbial contributions not only to our knowledge of genetics but also to our understanding of evolution, energetics and the unity of all terrestrial life. Far more substantial than today's human celebrities, the iconic figures of bioscience at that time were *Escherichia coli*, *Aspergillus niger* and *Rhodospirillum rubrum*.

Looking back over the emergence of molecular genetics during the past 50 years, from the deciphering of the genetic code to the advent of recombinant DNA, the recognition of the cell cycle and the latest developments in intra- and intercellular signalling, it's clear that bacteria and viruses (especially phages) have been major players at every stage. Genetically modified interferons, insulin and other drugs, which are now saving countless lives and ameliorating many more, comprise just one practical outcome of the knowledge gained from this great collaboration between microbes and humans.

Bacteria are also moving rapidly into clinical practice in their own right (Baker, M., 2005, *Nat Biotechnol* **23**, 645). One that has entered clinical trials recently is *Streptococcus lactis*, genetically modified not to make enamel-eroding lactic acid, which is introduced into the mouth to replace those strains that do rot teeth. Others include a *Lactobacillus lactis* recombinant that secretes a therapeutic protein to help Crohn's disease patients; and a *Lactobacillus crispatus* strain to combat recurrent urinary tract infection. Meanwhile *Clostridium novyi*, an anaerobe that can infect hypoxic regions within tumours, is showing promise as a means of delivering chemotherapeutic agents (Cheong, I. *et al.*, 2006, *Science* **314**, 1308).

Reviewing the scientific insights now being provided by micro-organisms in abundance, one is impressed above all by their diversity. A fast-evolving feline immunodeficiency virus, for example, has revealed details of the population structure and demographic history of its natural wildlife host (the cougar) that were impossible to obtain by any other means (Biek, R. *et al.*, 2006, *Science* **311**, 538). Studies on the deep-sea-living *Photobacterium profundum* have yielded a first glimpse into the molecular basis for life in the largest portion of the biosphere (Vezzi, A. *et al.*, 2005, *Science* **307**, 1459), and single-celled algae have shown how abnormalities in human cilia can explain the basis not only of Bardet–Biedl syndrome but also of many other conditions too (Vogel, G., 2005, *Science* **310**, 216).

Whatever the truth behind contemporary cogitations regarding global warming, it's clear that microbial life will be here long after we have departed, just as it flourished on Earth aeons ahead of our arrival. Those verities alone tell us much about the resilience and diversity of micro-organisms. The articles in this issue of *Microbiology Today* illustrate just four of their countless areas of influence. While human ingenuity has fashioned the fabric of the planet of today, microbial versatility has an even greater range of terrestrial activity to its credit.

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◀ Ruins of stone houses in County Mayo, Ireland, abandoned during the Irish potato famine. *Richard Cummins / Corbis*

Disease rather than military tactics was a major influence on Napoleon's downfall, as **Gavin Thomas** describes.

Napoleon and typhus: a tale of two generals

History has been shaped by many elements beyond human control, and infectious disease must rank as the single most important of these. Warfare, with the particular stresses and strains felt by its combatants, is a human activity that is highly susceptible to intervention by our microbial cousins. This might not be immediately apparent in our schoolboy histories, which concern great generals and their feats of bravery and stratagem. However, if one digs a little deeper into the historical records, it is often epidemics that have made a major contribution to the outcome of conflict – often before the opposing forces have even set eyes on each other.

Napoleon Bonaparte was a great general, politician and leader of his people. He became ruler of France in 1799, being crowned Emperor in 1804, and then systematically conquered the majority of Europe, enjoying 10 years of astonishing military success. In 1812 he was at the peak of his powers, had assembled the largest army in the world with upwards of 500,000 soldiers and was about to embark on a well-planned assault on Russia. Two years later he had attempted suicide and had fled France. General Napoleon's downfall was due to many things, but as we will see 'General Typhus' was one of his most bitter opponents.

A warning from the Caribbean

Napoleon had had at least one warning about the power of infectious disease in determining the outcome of a campaign, when in 1802 he sent his brother-in-law General Charles Victor Emmanuel Leclerc on an expedition to Saint-Domingue (now Haïti) to restore control over this French colony. Over the preceding few years a native general, Toussaint L'Ouverture, had created an almost autonomous state which had started from a slave rebellion in 1791 and the French wished to reinstate control by force.

Leclerc arrived with 25,000 men and, not surprisingly, quickly overwhelmed the natives and forced them into the interior. The French tricked Toussaint into agreeing to capitulate and he was shipped off to France where he quickly died, but when the French announced that they would be reinstating slavery, the natives, under the leadership of Jean-Jacques Dessalines, began another uprising. However, by this time the French forces had been absolutely decimated by yellow fever: 22,000 of them were dead by 1803, including General Leclerc. His replacement, Rochambeau, was defeated by Dessalines' forces at the Battle of Vertières, and in 1803 the remainder of the French force, less than 3,000 men, evacuated the island. Dessalines subsequently claimed the independence of Haïti and history notes this as the only nation to have gained its independence from a successful slave revolt – but history should also note that a virus had something to do with it!

▲ Napoleon (1769–1821) crossing the alps (1801). *The Bridgeman Art Library / Getty Images*

The Grande Armée in Russia

The campaign into Russia was Napoleon's greatest gamble and ultimately led to the destruction of his Grande Armée and the breakdown of his empire. One of his stated aims was the liberation of Poland from the Russians and it was in crossing this country that his soldiers first came across 'General Typhus'. The quality of life in rural Poland at the start of the 19th century was not high; in the villages most people lived in hovels heavily infested with insects, and typhus had been endemic in Poland and Russia for many years.

The retreating Russian army had done its best to turn Poland into a wasteland during its withdrawal and the autumn of 1812 was unexpectedly hot, meaning that water and other supplies were short. This environment provided ideal conditions for the spread of lice and subsequently *Rickettsia prowazekii*, the causative agent of epidemic typhus. The average French soldier was dirty and sweaty and was living in the same clothes for days on end, perfect for lice to find a home in the seams of his clothing. The excrement of the lice then contaminated the clothes and skin of the soldiers and even the smallest scratch was enough for the bacteria to infect the body. The soldiers also were sleeping in large groups in confined spaces and here the lice could quickly move to uninfected soldiers and deposit their bacteria-laden excrement.

A month into the campaign in July 1812, an incredible 80,000 soldiers had died or were incapacitated by typhus. Although the French army probably had the best medical and sanitary facilities of any in the world, it simply

Epidemic or louse-borne typhus

The causative bacterium of this disease, *Rickettsia prowazekii*, is transmitted between humans by lice. These become infected when biting affected people and pass on the bacteria in their faeces through bite wounds. The incubation period is 1–3 weeks and symptoms include high fever, headache and weakness; a rash appears after a few days. Complications leading to serious illness and death may develop, involving damage to the central nervous system, kidneys, heart and lungs.

Severe epidemics of typhus were common in times of war and famine; up until World War II, typhus claimed more victims on the battlefield than fighting, causing nearly 3 million deaths in World War I. Now lice can be controlled with improved hygiene and insecticides, and the infection treated with antibiotics.

> *'Typhus, with its brothers and sisters – plague, cholera, typhoid, dysentery – has decided more campaigns than Caesar, Hannibal, Napoleon and all the inspector generals of history.'* Hans Zinsser

could not cope with this level of disease. Of course, they did not know that lice were transmitting the disease and so once the infected lice population was established in the army, they were impossible to get rid of. The soldiers were not able to change their dirty clothes or wash themselves and deaths continued at massive rates.

As Napoleon's army pushed further East, the Russians continued their retreat and lay-to-waste strategy almost as far as Moscow itself. It was only then that the French Army actually engaged the Russians, and even here, at the battle of Borodino, the Russians committed just a small number of their forces; the rest had retreated further into the East. Napoleon entered Moscow unopposed on 14 September, but with only 90,000 of his original force: typhus had claimed over 10,000 in the past week alone.

Napoleon had banked on Tsar Alexander I capitulating after the capture of Moscow, but Alexander had no intention of doing this and was able to play his trump card: the Russian winter. The autumn had been surprisingly mild and Napoleon jested with his generals that a Russian winter couldn't be much colder than one at Fontainebleau! Moscow was as poor in providing supplies to the French army as the countryside they had passed over in their journey from France, and despite an extra 15,000 reinforcements arriving during their month-long stay, about 10,000 of the existing soldiers died from typhus. Napoleon finally decided to leave Moscow on 19 October with about 95,000 tired, dirty and famished men. The retreat back to France is a sad story of disease, extreme cold and starvation and only 40,000 of the original Grande Armée made it back, as few as 10,000 of them being in any state suitable for further duty.

Amazingly Napoleon managed to raise a new army of nearly the same size in 1813, but it was nothing like his original army of experienced veterans and almost half of this new army were lost to typhus in the same year, effectively halting Napoleon's plans for European domination.

Bioarcheaology and the Grande Armée

In 2001, a mass grave of French soldiers was discovered in Vilnius in Lithuania, where parts of the army were garrisoned during the retreat from Russia. It was estimated to contain 2000–3000 bodies, and buttons were found from around 40 different French regiments. A group of scientists, led by Didier Raoult at the Université de la Méditerranée, Marseilles, has examined these burials and has been able to amplify DNA sequences from the remains of lice and from dental pulp from the soldiers' teeth. These identified the presence of *Rickettsia prowazekii* in some of the teeth (positive signals were found in 3 out of 35 different soldiers) as well as *Bartonella quintana*, the causative agent of trench foot, in some teeth as well as in lice.

That modern molecular techniques can provide support for the reports of French army surgeons written almost 200 years ago must provide unexpected evidence for historians of medicine. However, they are already well aware of the strong connection between microbes and warfare as succinctly described by historian Carole Reeves from the Wellcome Trust Centre for the History of Medicine, '*wherever there is warfare there is always infectious disease*'. It is undeniable that Napoleon's career, like many other generals in history, was at least partly shaped by microbes.

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Further reading

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Raoult, D. & others (2006). Evidence for louse-transmitted disease in soldiers of Napoleon's Grand Army in Vilnius. *J Infect Dis* **193**, 112–120.

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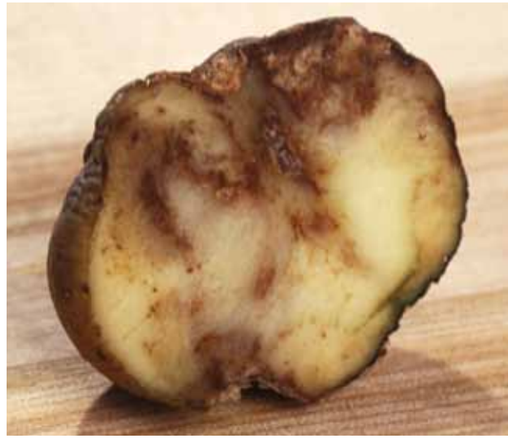
◀ French soldiers from Napoleon's Grande Armée suffering from typhus, lying in the streets of Vilnius. Tinted lithograph by E. Leroux after A. Raffet. *Wellcome Library, London*

▲ False-coloured scanning electron micrograph of a pubic louse (*Phthirus pubis*), a vector for *Rickettsia*. © *Dennis Kunkel Microscopy, Inc.*



Phytophthora: a blight on Ireland

Late blight of potatoes caused by *Phytophthora infestans* had an enormous socioeconomic impact on 19th century Ireland. According to **Gareth Griffith**, the outbreak also heralded a landmark in the development of microbiology, especially in the areas of plant pathology and crop protection.

As the world's fourth most important food crop, the potato is a major part of the Western diet. It first became known to Europeans after the conquest of the Andean Aztecs by the Spanish in the early 16th century. The route whereby the potato reached Ireland is unclear. Reports that Sir Walter Raleigh introduced the potato through his extensive estates in County Cork or that it arrived via the fleeing Spanish Armada are unsubstantiated, though there was extensive trade between Ireland and Spain in the 16th century.. Spanish seafarers were certainly quick to recognize that potatoes were well-suited for ship's stores, providing a useful source of fresh food and vitamins. With increasing transatlantic sea travel at this time, it is likely that there were numerous introductions to Europe.

In Ireland, the high rainfall and mild winters in the west were conducive to the cultivation of potatoes and from the early 18th century much of the population was dependent on this crop, especially the high-yielding 'Lumper' variety. Apparently, adult males consumed over 6 kg per day. A further contributory factor to the success of the new crop was the small size of land holdings in Ireland. Most families were forced to live off small plots, often on marginal soils; potato yields were greater than for other crops and the plants were generally less susceptible to disease. The availability of potatoes was probably a major contributory factor to the continued growth of the population in Ireland which exceeded 8 million by 1841.

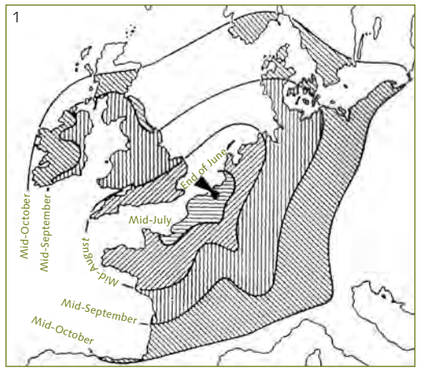
Arrival of late blight

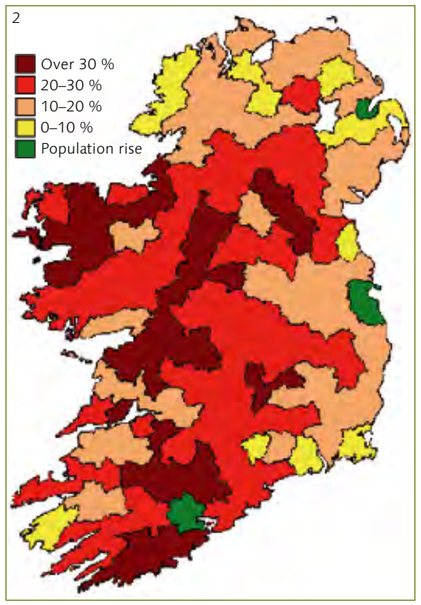
The pandemic of late blight (originally called potato murrain or gangréne humide) has its earliest confirmed origins on the US east coast in 1843, probably due to the spread of the pathogen in tubers on the trade routes from Southern/Central America. Irish immigrants had introduced potato cultivation to the USA in the 1790s and the crop was widely grown along the east coast. The next jump, and the one that secured the infamy of this pathogen, was across the Atlantic in 1845. Potato disease was first reported in Belgium in May and air-borne dispersal of the sporangia permitted its rapid spread, so that it reached Ireland in July, arriving in western Ireland by September (Fig. 1). Though crops in many parts of Europe were badly infected by the new disease, the 1845 crop in Ireland was better than average. Unfortunately, during storage in clamps, tubers infected in the field developed blight symptoms and blackened, making them inedible and providing ample inoculum for the 1846 season. Severe food shortages in early 1846 were exacerbated by a total crop failure later that year.

As in more recent famines, the greatest damage was caused by failures to recognize the seriousness of the problem and to mobilize chains of supply to bring grain to the areas most heavily dependent on potatoes. The insensitivity of landlords was also shocking, with widespread eviction due to unpaid rents. In the small town of Kilrush, Co. Clare, there were 7,000 evictions in the second half of 1848. Much blame was also laid at the door of the government in London and specifically its tardiness in repealing the much-hated, anti-free-trade Corn Laws which had maintained high wheat

◀ Far left. The distinctive sporangia of *Phytophthora infestans* which were observed by Berkeley and others to emerge '*out of the mouths of stomata*' of infected leaves. *G.W. Griffith & A. Edwards*

▲ Centre and right. The symptoms of late blight on leaves and tubers. The small black lesions enlarge and coalesce, leading to defoliation. Sporangia washed by rainfall from leaves infect the tubers which develop a brown marbled appearance during storage. *Garden World Images / D. Bevan (leaf) & USDA Photo Library (tuber)*





▲ Fig. 1. The spread of ***P. infestans*** through north-west Europe in the summer of 1845. *Reprinted by permission from Macmillan Publishers Ltd: Nature, London (Bourke, P.M.A., Emergence of potato blight, 1843–6.* ***203****, pp. 805–808), © 1964*

▲ Fig. 2. Depopulation of Ireland caused by the famines. *Public domain – taken from Edwards, R.D. & Williams, T.D. (1956) The Great Famine: Studies in Irish History 1845–1852 (Dublin: Brown & Nolan)*

prices by preventing imports. According to the Nobel prize-winning economist Amartya Sen, the mortality rate in Ireland in the 1840s was higher than in any other recorded famine. The Irish nationalist and politician John Mitchel went as far as to write '*the Almighty sent the potato blight, but the English created the Famine*'. The resulting mass mortality and emigration – it is estimated that 1 million people died and a similar number emigrated between 1845 and 1849 – had a profound effect on the history, not only of Ireland, but also of the industrializing areas of the UK and the US east coast. The depopulation of Ireland, which began in 1845 as a result of the famine (Fig. 2), led to the disappearance of the cottier (crofter) class of peasant and continued for 150 years, with 4.5 million emigrating between 1851 and 1921. It is only very recently that the population of Ireland has begun to grow again.

The origins of plant pathology

The causes of the potato famine were the subject of much speculation as soon as the disease appeared. The prevailing view at the time was that all diseases were caused by 'bad air' or 'miasma', with some authors blaming deterioration of potato breeding stock, damp weather or an origin in outer space. The idea that plant diseases were due to fungi was rather heretical, and microbial growth in diseased tissues was generally viewed as a consequence rather than a cause of disease. The 'fungalist' view of plant disease had long been propounded, notably by Edouard Prévost (in 1807 for the wheat bunt *Tilletia*), Agostino Bassini (in 1835 for muscardine disease of silkworm by *Beauveria bassiana*) and von Martius (in 1842 for 'dry rot' of potato by *Fusarium coeruleum*), but was not accepted by the scientific establishment. In July 1845, as late blight began to take its toll, the French cleric Edouard van den Hecke described the sporulation of a fungus from blighted leaves, giving it the name *Botrytis*. Several other eminent mycologists went into print in support of this idea, notably Charles Morren in Belgium and Camille Montagne in France. With remarkable prophetic ability, in August 1845 Morren suggested the use of copper sulfate/lime to protect seed potatoes and destruction of diseased tissues, strategies similar to those which became the mainstays of control of late blight until the 1930s, although it is unclear where his ideas originated. Meanwhile Montagne christened the fungus *Botrytis infestans*.

The Rev. Miles Joseph Berkeley, a Northamptonshire parson and prominent mycologist, who had been in contact with the continental 'fungalists', first observed the disease in early September and rapidly ascribed to the fungalist theory. However, the scientific establishment in Europe remained unpersuaded and the fungalists were widely pilloried. So vehement was this opposition in the later 1840s that only Morren refused to moderate his opinion. Montagne even suggested that his specific epithet *infestans* should be changed to *fallax*. Berkeley's behaviour at this time suggests a degree of fence-sitting. Despite bravely writing '*I believe the fungal theory to be the correct one*', in 1846, he skilfully avoided much of the resulting flak, being, in the words of Austin Bourke, more of a '*believer than a missionary*'. The debate rumbled on until 1861 when Anton de Bary published his papers on the life cycle of the pathogen, eventually renaming it *Phytophthora infestans* in 1876. Although its name has remained stable for over a century, *P. infestans* and its numerous pathogenic relatives now reside in the phylum Oomycota, in the Kingdom Stramenopiles (heterokonts), and thus in fact are only very distantly related to the members of Kingdom Fungi. Despite many similarities in gross morphology with Fungi (hyphal growth, etc.), the oomycetes are now recognized to possess several distinctive ultrastructural features."

From a 21st century perspective, this whole debate about the origin of a disease so consistently and obviously associated with the distinctive reproductive structures of *P. infestans* might seem odd. Had these events occurred a few decades later, with due regard to Koch's postulates, the matter might have been settled more quickly and poor Morren would have been vindicated in his own lifetime (he died young in 1858). Berkeley, though older, lived to a ripe age and is with justification known as the father of English mycology.

Modern migrations of *P. infestans*

The taxonomy of fungi and other multicellular eukaryotes is based on the morphology of the sexual reproductive structures. In renaming *P. infestans* without having ever found its oospores, De Bary predicted where these might be found and what they would look like. Despite several conflicting reports in the late 19th century of the discovery of oospores in *P. infestans*, it was only when isolates were obtained from the Central Highlands of Mexico, the area of greatest diversity and presumed to be the evolutionary origin of the fungus, that oospores were found. It was realized that only the A1 mating type had originally escaped from Mexico and that outside Mexico the fungus relied totally on asexual reproduction. It remains a matter of debate whether *P. infestans* was transmitted directly from Mexico to the US or whether there was an intermediate migration to the Andes, followed by transport in the new steamships carrying guano from Peru to the US and Europe.

A further twist in the potato blight story came in 1976 when a drought in Europe led to poor potato crops and the need to import potatoes from abroad, including Mexico. Over the next 20 years numerous papers documented the discovery of the A2 mating type in various European countries. Use of molecular markers has demonstrated that the genetically uniform 'old' genotypes (the 'Ib' mitochondrial haplotype) prevalent up to the 1970s were progressively superceded over the next 15 years by a more diverse range of 'new' genotypes. The presence of both mating types opened the possibility of sexual reproduction, allowing not only the generation of additional diversity among pathogen populations, but also the formation of thick-walled oospores which could remain dormant in soil for prolonged periods. As with all plant pathogens, severe selection pressure for pathogen evolution is imposed by farmers (assisted by scientists). In the case of late blight this was due to both the breeding of progressively more resistant cultivars and the introduction of highly effective systemic phenylamide fungicides in the late 1970s. 'Old' genotypes were highly susceptible and resistance arose amongst the new genotypes, though the extent to which sexual reproduction plays a role in the modern evolution of the pathogen is still uncertain. Recent genetic analysis of the pathogen from herbarium specimens collected in the 1850s has revealed these to be of the 'Ia' rather than the 'Ib' haplotype, as had been widely assumed. Thus it seems that at least one pan-global migration of *P. infestans*, probably during the early 20th century, has gone unnoticed.

Late blight is still the most important disease of potatoes and commercial production is not viable without fungicides. Fungicide mixtures and targeted application based on meteorological data (blight forecasts) are used to great effect, but the delisting of many products under the EU Pesticide Directive and environmental concerns (some farmers spray their crops 10–20 times in a season) provides impetus for potato breeding and more effective fungicide application. Copper-based fungicides were widely used for late blight control between 1885 and 1935 and are still used for organic potato production.

Other *Phytophthora* diseases

The genus *Phytophthora* contains over 60 species, all of which are plant pathogens, with many more likely to be found. Unlike *P. infestans* which infects foliar tissues and is wind-borne due to its dehiscent (detachable) sporangia, most *Phytophthora* spp. are soil-borne root pathogens. Other members of the genus currently causing serious problems around the world have mysterious names such as Jarrah dieback of Eucalyptus, Black Pod of Cacao and Sudden Oak Death. It is ironic that free trade, as enforced by the WTO and for which the repeal of the Corn Laws in 1846 was a key step in the process, leading to the current global market for plant produce, leaves us at greater risk of suffering at the hands of introduced plant diseases.

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How two antimicrobials altered the history of the modern world

Milton Wainwright speculates on how the outcome of World War II might have been very different if novel antimicrobial drugs had not been available.

The sulpha drugs, together with penicillin and the other antibiotics that followed, had a massive effect on medicine, saving countless lives in peace and war, as well as making possible many of the medical advances we now take for granted. The first two drugs had a particular impact in WWII and while the Allies had unlimited supplies of penicillin from D-Day onwards, the Axis powers had to rely upon the less dependable sulphonamides.

The following two stories show how these novel antimicrobials changed the course of WWII, and thereby modern history. The first story is relatively well known, how Winston Churchill's life was saved by a new sulphonamide. The second and more intriguing story has only recently come to light and begs the question – did the Allies inadvertently save Hitler's life in July 1944?

▼ Winston Churchill giving his traditional 'V for Victory' salute on 10 November 1942. *Reg Speller / Hulton Archive /Getty Images*

▶ Adolf Hitler at the Berghof, Berchtesgaden, Upper Bavaria, Germany, in the late 1930s. *Hugo Jaeger / Timepix / Time Life Pictures / Getty Images*

Churchill's cure

By the time WWII began in Europe the sulphonamides were well established as life-saving drugs. Discovered by Domagk, as Prontosil, the new drugs had been further developed and were showing their worth in treating childbed fever, pneumonia and septic wounds. Sulphonamides were used to great effect to treat the wounded at Pearl Harbor and continued to be used in the Pacific and, alongside penicillin, throughout the War.

One type of sulphonamide produced in England by May and Baker undoubtedly saved the life of Winston Churchill and thereby had a spectacular effect on the outcome of the War, and civilization in general.

Late in 1943, at the height of the War, Churchill made a trip to the Middle East, meeting Chang Kaishek in Cairo, Stalin in Tehran and then on his return to Cairo, Roosevelt. Early in the morning of 11 December, he boarded a flight to Tunisia to spend a while relaxing at Eisenhower's villa in Carthage. But things began to go wrong from the start. Off course, the plane was forced to make an unscheduled stop some 40 miles from Carthage. Churchill was left stranded in a cold wind, sitting on his luggage, for more than an hour. In the evening, he complained of a sore throat and bad headache and soon developed a temperature of 101 F. His personal physician, Lord Moran, was called and he used a portable X-ray machine to show that Churchill had a shadow on his lung that indicated only one thing; the Prime Minister had pneumonia. Moran immediately prescribed a new, British-developed sulpha drug (sulphapyridine), commonly referred to as M&B, after its manufacturers. Churchill's condition got worse, however, and he developed heart disease. The lungs of the 69-year-old Prime Minister became congested and his condition deteriorated rapidly. Then, miraculously, under the influence of the new drug, Churchill began to improve, and by Christmas he was working again. At the end of December he was transferred to Marrakesh to convalesce and was able to return to England by early January 1944.

M&B 693 undoubtedly saved Churchill's life in 1943, and, by allowing him to return to work on plans for the Anzio invasion of Italy and the Normandy invasion, affected the course of WWII. We obviously have no idea what would have happened if Churchill had not been saved by M&B. Perhaps his successor would have taken a completely different approach when it came, for example, to supporting Tito in Yugoslavia, to the aerial bombing of Germany or relations between Stalin and the Allies. What is not in doubt however, is that without M&B the outcome of WWII would, for better or worse, have been very different.

Hitler's escape from death

Antibacterial agents, of course do not discriminate – they save the wicked as well as the righteous. The next story provides a perfect example of the former, showing how, in all likelihood, penicillin, the antibiotic that has reduced mortality and relieved so much suffering, also saved the life of Adolf Hitler.

Hitler lived a charmed life, so much so that one might believe the Fates were, for a long time, on his side. He survived wounding in the First World War, life in Munich during the interwar years, and then numerous near misses and assassination attempts as he rose to power, even while he was Führer.

One assassination attempt that almost succeeded involved Count Claus von Stauffenberg. In 1944 von Stauffenberg smuggled a briefcase containing a bomb into Hitler's briefing hut at the Wolf's Lair in East Prussia. As he made his hasty exit, he heard an enormous explosion, which he assumed must have killed everyone in the hut, including Hitler. Unfortunately he was wrong; Fate had once again smiled on Hitler. Soon after von Stauffenberg placed the bomb, one of Hitler's adjutants moved it behind a thick wooden table leg. This helped dampen the blast, leaving Hitler alive, although badly injured. von Stauffenberg, his family and co-conspirators were not so lucky; some committed suicide, while most were hunted down by the Gestapo and the SS, tortured and then brutally murdered.

Hitler's personal physician, Theodor Morell, arrived almost immediately on the bomb scene and began administering first aid. It was clear, however, that Hitler's life hung on a thread. Morell is usually portrayed as a quack who did more harm than good to his principal patient. Despite the fact that he kept Hitler high on drugs, Morell also did some surprisingly imaginative work on a novel probiotic called Mutaflor, which he prescribed to ease Hitler's long-term stomach problems. Morell probably began treating Hitler with sulpha drugs after the explosion, but he had a small supply of a much better drug, penicillin, in his arsenal.

The Germans and their allies had been remarkably slow in developing their own penicillin so, by the time of von Stauffenberg's assassination attempt, they had only small amounts of Axis-produced penicillin. Doubtless these meagre supplies would have been available to Morell for use in treating Hitler and his criminal henchmen. Fortunately for the Führer, Morell had access to the more potent American and British penicillin. The Americans, in particular, had decided to supply their field doctors with penicillin, and fighter and bomber pilots carried a supply when they flew over Germany. Penicillin was also sent through the Red Cross to prisoner-of-war camps. Morell clearly would have had access to some of this Allied penicillin; Adolf Hitler would naturally have been the first person to receive it. My own recent researches in fact leave little doubt that Morell used Allied penicillin to help save Hitler's life in 1944.

A Germany at war without Hitler in 1944 would have been very different. Perhaps the Germans would have continued to fight under a new Führer. Conversely, a German Army without Hitler's meddling may have done better at Stalingrad and on D-Day; we shall never know. Maybe the Germans would have sued for peace and all those who died in the war and the concentration camps, from 1943 onwards, would have survived; the speculation is endless.

▲ Hitler's personal physician Theodor Morell in Wilhelmshaven for the launching of the battleship Tirpitz. *Hugo Jaeger / Timepix / Time Life Pictures / Getty Images*

For good or for worse, antimicrobial agents have dramatically changed the course of history. Although we usually emphasize their positive effects in saving lives, these two stories show that history is never simple and that antimicrobials have had a complex impact on our modern world.

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Vaccination spells the end for a devastating plague

At a time when highly pathogenic virus diseases such as avian influenza and AIDS are threatening to overwhelm us, **Tom Barrett** reports some good news: the virtual global eradication of rinderpest virus through a concerted vaccination campaign.

Rinderpest, or cattle plague, bears all the hallmarks of a disease capable of causing economic and social disaster. Wherever it has occurred, it has caused terrible destruction of cattle, adversely affected agriculture and rural livelihoods, bringing in its wake famine and starvation.

Rinderpest is a morbillivirus, its closest relative being human measles virus. Infections begin in the upper respiratory tract and, after a variable incubation period, spread from the local lymph nodes via the lymph and blood to other lymphatic tissues, before progressing to the mucosal surfaces, causing the formation of necrotic lesions and discharges from the nose and eyes. The gut mucosa is also affected, leading to severe and bloody diarrhoea and death as a result of dehydration. Virulent strains also affect the immune system and cause an increased susceptibility to other pathogens. During vaccination campaigns, farmers were made aware of rinderpest by advertising it as the disease of the three D's (discharge, diarrhoea and death).

Disease and warfare

Rinderpest has long been associated with wars and invasions where there is uncontrolled movement of people and their cattle. Invasion by the Huns into Europe in the late 4th century resulted in an outbreak of a highly contagious disease of cattle which was clearly identified for the first time as rinderpest by the Latin writer Severus Sanctus Endeleichus. Subsequent accounts describe pandemics that followed the Mongol invasions of Western Europe. Cattle plague was probably the first agrobiological weapon ever employed.

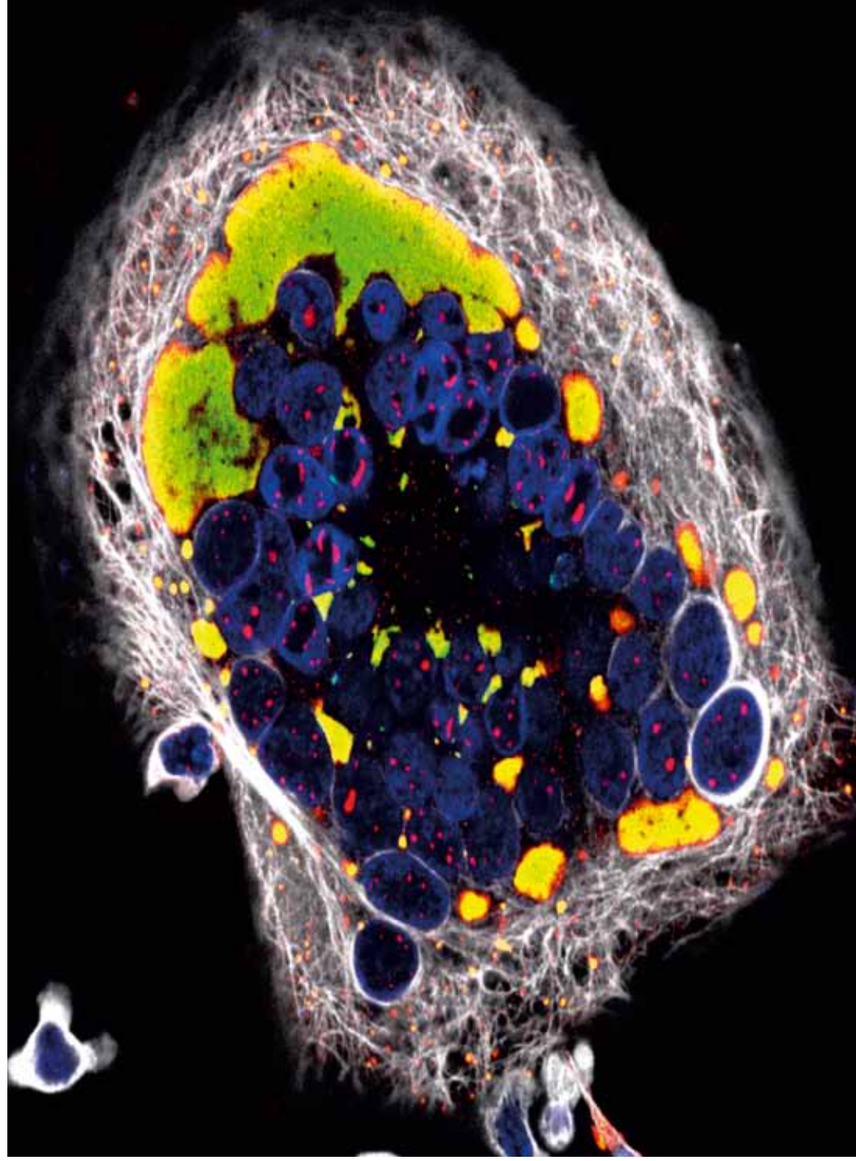
'*The secret weapons of the invaders were Grey Steppe oxen. Their value was a strong innate resistance manifested by slow spread of virus and by the absence of clinical signs. A troop of Grey Steppe cattle could shed rinderpest virus for months provoking epidemics that devastated buffalo and cattle populations of invaded countries. The sequelae were no transport, untilled fields, starving peasants, and overthrown governments*'.

Rinderpest and veterinary medicine

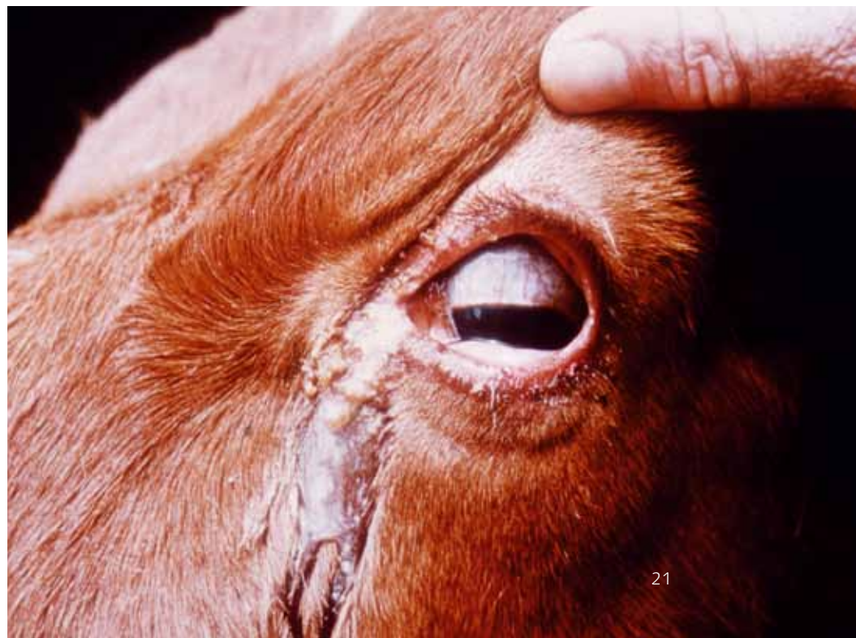
Veterinary services were pre-occupied with rinderpest control for much of the 20th century. In the 1920s the Office Internationale des Épizooties (OIE), a body that acts as the World Organization for Animal Health, was established in response to the introduction of rinderpest into Australia and South America by trade in live animals. When the United Nations was established in 1945, one of the first specialized agencies to be set up was the Food and Agriculture Organization (FAO) with a mandate to consider ways that the activities of veterinary organizations could be properly co-ordinated internationally, with a particular view to mitigating the widespread ravages of animal plagues, especially rinderpest.

Control measures

It was not until the pandemics in Europe in the early 18th century that the disease was first described scientifically and that effective control measures were introduced. In 1711 Pope Clement XI ordered his physician Dr Giovani Lancisi to investigate the cause and prescribe ways to control the plague that had killed so many cattle in the Papal herds. Lancisi understood the nature of infectious diseases without knowing their cause and he proposed slaughter of infected animals to reduce disease spread, burial of the carcasses in lime, movement controls on cattle and inspection of meat. He also introduced the idea of quarantine and his



▲ A giant syncytium formed when a B95a cell monolayer was infected with a version of the virus expressing GFP inserted into the polymerase gene. The nucleocapsid protein is stained red, the cellular tubulin filaments white and the nuclei blue. Where the virus nucleocapsids form, by co-location of the polymerase and nucleocapsid proteins, the cytoplasm stains yellow. *Tom Barrett*



▶ An animal infected with rinderpest showing a severe ocular discharge, a major clinical sign of infection. The virus antigen present in the discharge can be used for rinderpest detection using the pen-side test. *Tom Barrett*

▲ Stamps issued in Ethiopia and other African countries in the 1970s to advertise the campaign against rinderpest. *Tom Barrett*

▶ The eradication of rinderpest during the 20th century. *Tom Barrett*

policies were backed by strong legal enforcement with severe punishments for transgressors. By rigorous application of these sanitary measures the disease was eliminated from Europe by the late 1800s. These methods are still applied today to control and eliminate animal diseases such as avian influenza and foot and mouth disease. The economic and social devastation resulting from the cattle plague was the impetus to establish veterinary schools, the first being at Lyon, France, in 1762. The ability to effectively control rinderpest was considered to be a measure of the quality of a country's veterinary service.

Rinderpest in Africa

With its origins in Central Asia, the virus was probably first introduced into Egypt in the early 1800s, but it did not cause a pandemic in Africa until the late 1880s. This outbreak probably started when infected zebu cattle from Aden or Bombay were imported to Eritrea (then part of Abyssinia) by Italian troops fighting colonial wars in the region. For over a decade the plague swept over a whole continent of susceptible animals. At this time veterinary services were virtually non-existent in sub-Saharan Africa. 80–90 % of cattle, buffalo, eland, giraffe, wildebeest, kudu and various species of antelope succumbed. In Kenya, the Masai people suffered starvation and, together with a smallpox epidemic that followed the cattle plague, were severely reduced in numbers. Great tracts of land were depopulated, which facilitated the subsequent colonization of Kenya. One account states that *'never before in the memory of man, or by the voice of tradition, have the cattle died in such numbers; never before has the wild game suffered'*.

Control through vaccination

During the 1950s and 1960s individual countries in Africa, the Middle East and Asia carried out national rinderpest control programmes based on a policy of mass vaccination. Goat-adapted vaccine was favoured in India and Africa, while East Asian countries used either lapinized or egg-adapted vaccines. These vaccines, although efficacious, were not safe for use in all susceptible animals and so had limited use; nevertheless, Russia and China succeeded in eradicating the disease during this period. There was little co-ordination between neighbouring countries and vaccination in much of southern Asia, the Middle East and Africa in the 1960s and 1970s was not carried out effectively. Despite spectacular early successes, vaccination was not carried out rigorously enough to eliminate all endemic foci, resulting in a major resurgence of the disease in the early 1980s. This led to such great economic losses that a more concerted effort to eradicate the disease by mass vaccination was proposed in 1986 and funded by the European Union.

A safe and efficacious vaccine

A factor which contributed greatly to the decision to eradicate rinderpest was the development in the late 1950s of a highly efficacious vaccine, safe to use in all susceptible ruminants, by Dr Walter Plowright at the East African Veterinary Research Organization laboratories in Kenya. His approach was to take a virulent needle-passaged strain of the virus, chosen because it did not form mouth lesions and so had a reduced ability to transmit between cattle, and infect bovine kidney (BK) cells in suspension. These were then allowed to form monolayers and infected cells could be identified when they either rounded up or formed multinucleate syncytia. The virus required many passages to become attenuated for cattle: in fact, its virulence actually increased over the first 10 passages as manifest by an increased mortality rate (rising from 60 to 100 %) and shorter average survival time post-infection (falling from 9 to 3 days). It had also become readily transmissible by contact as it acquired the ability to form mouth lesions. By the 16th passage, however, the virulence had returned to a level equivalent to that of the parent virus. The ability to cause lesions, diarrhoea or death of the host also diminished after the 16th passage and from the 21st passage onwards only temperature reactions were observed. Finally, by 70th, 90th or 122nd BK cell passages, even these temperature reactions disappeared. This has turned out to be the most successful veterinary vaccine ever produced, saving millions of dollars annually and ridding farmers in the developing world of a devastating plague. In their introductory remarks in the published paper the authors modestly stated that they had, incidentally, furnished another attenuated strain suitable for the immunization of cattle (Plowright & Ferris, 1959)! If global eradication of rinderpest is achieved it will be the first animal viral disease for which this has been possible and only the second after smallpox. For this work, Dr Plowright was awarded the FAO's World Food Prize in 1999, the equivalent of a Nobel Prize in the area of food research. This breakthrough convinced veterinarians and scientists that rinderpest could be cost-effectively brought under control or even eradicated in many parts of the world.

Monitoring the effectiveness of vaccination

The vast number of serum samples that had to be analysed to monitor the effectiveness of vaccination posed huge logistical problems. A simple, high-throughput competitive ELISA system, suitable for sera from all species, was developed at the World Reference Laboratory in Pirbright. A network of laboratories, co-ordinated by the FAO laboratory at the International Atomic Energy Agency (IAEA) in Vienna, was set up in each of the countries involved to ensure that local staff received effective training and that standards were maintained by an external quality assurance system. A rapid 'pen-side' test was also developed for diagnosis by local veterinarians during an outbreak. This speeded up reporting and obviated the need to await laboratory confirmation of disease. The test was used effectively to eliminate the last foci of infection from Pakistan.

The global rinderpest eradication campaign

In 1986 regional eradication campaigns were begun in the endemic regions: sub-Saharan Africa, South Asia and West Asia. In areas of unrest, community based animal health workers were used for vaccination and seromonitoring. In 1992, based on the success of the regional campaigns, the FAO agreed that global eradication of rinderpest was justified and feasible. The Global Rinderpest Eradication Programme (GREP) was launched formally in 1994 as the prime target of the then newly established priority programme, EMPRES (Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases). This was to be a globally co-ordinated programme linking the existing regional and national efforts and with a time-bound target to achieve global eradication by the year 2010. The great efforts put into this project have ensured that the whole of the Asian continent (West, Central, South and East Asia) is now free of rinderpest, Pakistan being the final country in 2003. Most of the African continent has also been declared rinderpest-free with only one potential focus of infection remaining in the Horn of Africa. The last time rinderpest virus was positively identified in this ecosystem was in 2001 in wildlife and 2003 in cattle.

With the introduction of RT-PCR for diagnosis, sequencing showed that there were three lineages of the virus circulating in the world at that time, one in Asia and two, African lineages 1 and 2, in Africa. The virus which remains in Somalia is lineage 2 which causes only a mild to sub-clinical infection in cattle, but severe disease in certain wildlife species, especially buffalo. It is proving difficult to generate firm surveillance data on whether or not lineage 2 virus still circulates in this ecosystem.

The endgame

In the eradication campaign, mass vaccination has ceased and we are in a period of active surveillance to designate countries in Africa as rinderpest-free. The last time disease was unequivocally detected in Kenya was in 2001 when in buffalo in the Meru National Park were found to have been infected. Wildlife in Kenya therefore acts as sentinels for the spread of disease from Somalia and so they are being intensively monitored for signs of rinderpest. It was feared that even if rinderpest were eliminated from the domestic cattle populations, wild ruminants might act as a reservoir of infection, but evidence shows that when the disease is eliminated from cattle it disappears from surrounding wildlife. Nevertheless, during outbreaks, infected wildlife can spread the disease over large distances and play an important part in its epidemiology.

Rinderpest eradication can clearly be achieved in the near future if lessons are learnt from the past and the necessary commitment and funding are sustained until there is scientifically sound evidence for its complete elimination. One factor that may inhibit achievement of the goal by the target date of 2010 is a situation of political unrest such as that in Somalia, the last endemic focus of the disease.

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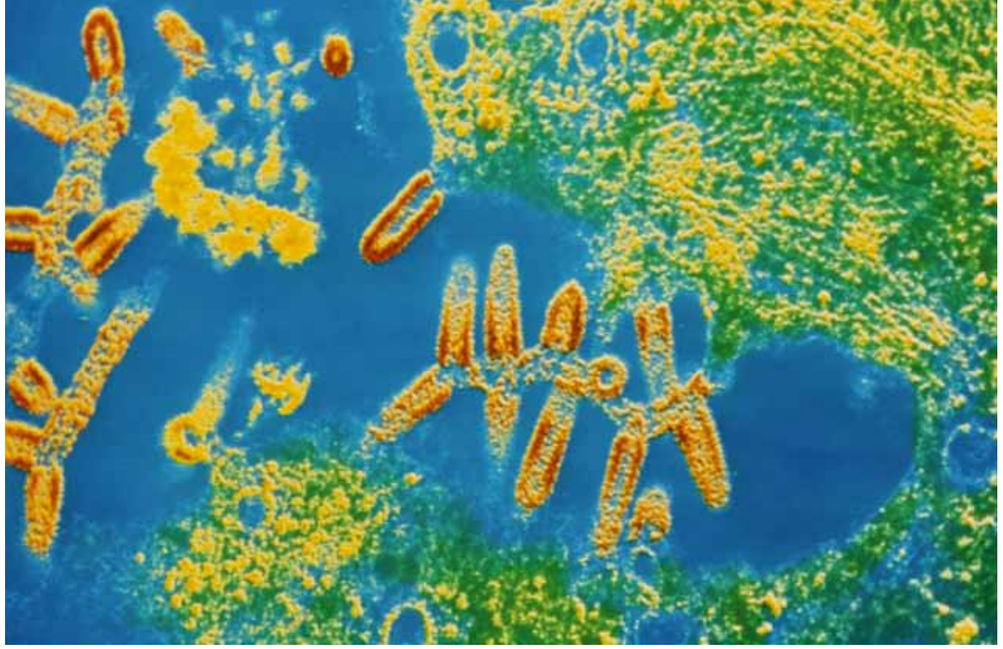
Wherever rinderpest has occurred, it has caused terrible destruction of cattle, adversely affected agriculture and rural livelihoods, bringing in its wake famine and starvation.

Evolution in action: a virological experiment of long duration

In an outpost of the Paris Pasteur Institute in Vietnam, rabies virus was serially passed from rabbit to rabbit from 1891 to 1953. **Jean Lindenmann** believes that this must be one of the longest biological experiments on record.



▲ False-colour TEM of rabies virions (red) budding away from host cell cytoplasm (green). The virions possess a protein capsid containing single-stranded RNA. A lipoprotein envelope surrounds the capsid. The virus is usually transmitted to humans through the bite of an infected dog or other animal. Symptoms appear after 10 days to 1 year and include fever, muscle spasm and hydrophobia. Death occurs within 4–5 days. *CNRI / Science Photo Library*

◀ The Pasteur Institute in Ho Chi Minh City, Vietnam. *Leonard de Selva / CORBIS*

The deliberate inoculation of diseases into animals or humans has a long history. In Europe, this began on a large scale in the 18th century in the fight against smallpox, with variolation (the inoculation of variolous material from person to person) and vaccination (initially the transfer of cowpox material from cow to man). Some present-day strains of the causative vaccinia virus have a long, chequered passage history which is difficult to trace. Too many different methods were employed and attempts made to regenerate certain strains by the addition of smallpox material or by 'retrovaccination' (the occasional return of human-passaged material to calves) to call this a single experiment. For many years vaccinia virus strains were passaged from child to child by doctors, not all of whom kept comprehensive records or used the same technique.

Rabies

Rabies is another viral disease for which experimentation began early. Pasteur's systematic laboratory work is well documented from 1881 on. By 1885 the basis of his vaccination method, consisting of serial passages of '*virus fixe*' from rabbit to rabbit, was established. Over the years the schedule of vaccine injections into patients was repeatedly modified, but the substrate for making the vaccine, infected rabbit spinal cords, remained unchanged. The Pasteurian method of rabies treatment spread very rapidly; by 1888 there were 20 institutes using it. Microbiological laboratories as Pasteurian outposts were created in several French colonies. In 1890, Pasteur offered Albert Calmette the opportunity to set up a microbiological laboratory in Indochina (Vietnam). Calmette arrived in Saigon (now Ho Chi Minh City) early in 1891. He soon realized that a disease locally known as 'mad dog disease' was rabies. A rabies vaccination section was created, which functioned, using essentially the same techniques, without interruption from 1891 until 1947. Serial rabbit passages of the virus continued until 1953. The French crew left Vietnam in 1959.

The comparative isolation of this outpost explains why, for more than

half a century, Roux's technique of sub-arachnoid injection was strictly adhered to, both for maintaining the virus by serial rabbit passages and for supplying the infected spinal cords from which the vaccine was made. This biological experiment, one of the longest on record, is unlikely ever to be repeated.

Serial rabbit passages of rabies in Saigon, 1891–1953

When Calmette arrived in Saigon he brought with him the virus that had been adapted from a rabid dog to the rabbit by Pasteur and Roux in 1882, and passed from rabbit to rabbit until the status of a *virus fixe* was reached, i.e. one whose incubation period in the rabbit would remain constant over further passages. During his 27 day voyage by sea, Calmette kept the virus active by intracerebral transfer from rabbit to rabbit. By sacrificing infected animals on the tenth day, three passages were sufficient to cover the voyage. On arrival in Saigon the virus had reached its 273rd passage.

Pasteur's vaccination procedure required infected rabbit spinal cords in which the virus had been attenuated by drying. The series of injections began with cords dried for 9–10 days and progressed to cords dried for shorter times (8, 7, 6, 5, 4, 3, 2 days). In order to be always ready to start a new treatment and to continue ongoing treatments, this required a large colony of rabbits and daily infection of fresh animals. The limited means Calmette had at his disposal precluded such extravagance. He relied instead on Roux's observation that infected spinal cords kept in glycerol retained their virulence for a long time. Calmette showed that the degree of attenuation that cords had reached after a given time of desiccation remained unchanged for at least 2 weeks once immersed in glycerol. This simplified his work enormously. To maintain the virus, serial passages from rabbit to rabbit, always using sub-arachnoid inoculation, were continuously carried out. The animals were sacrificed shortly after presenting the first unmistakable symptoms of the experimental disease. Their spinal cords supplied the seed for the next passage. Starting in February 1891 with the 273rd passage, the virus reached its 3,080th passage by 1953.

The virus Calmette had brought with him was supposedly *virus fixe*, its incubation on standardized inoculation into rabbits lasting 7 to 8 days, death occurring on the 11th or 12th day. In its 1,518th passage (January 1925) the Saigon virus induced paralysis on day 6 and death on day 10. By 1935 (around passage 2,000), the incubation period had shrunk to 4 days, with death occurring on the 6th day. At the same time the Paris series had only reached the 1,540th passage, and the incubation time there was 6 days, with death on the 10th day equivalent to the 1,518th passage in Saigon 10 years earlier. The Saigon virus remained unchanged from 1935 to 1953.

Discussion

When an attempt is made to adapt a virus to a new host species, often the virus is lost after a few passages, or it becomes progressively more virulent for the new host. But this does not always happen, as shown by the 19th century practice of arm to arm smallpox vaccination when the virus did not gain in virulence for man. On the contrary, the vaccinators were convinced that the virus was losing its vigour, no longer producing high fever, beautiful pustules and solid immunity. This shows that serial passages alone do not guarantee increases in virulence.

More important is the selective pressure applied. In choosing children as virus donors, the vaccinators probably did not take the sickliest looking or those who showed secondary pustules, but selected relatively healthy, well nourished, cheerful youngsters who enjoyed being the centre of attention. They were the least seriously ill of each group. In addition, the whole logistics required predetermined,

▶ Louis Pasteur celebrated on a 1966 French 5 Franc note. *Prof. Beat Rüttimann, Institute for the History of Medicine, Zürich, Switzerland*

For more than half a century, the rabies virus was maintained by serial rabbit passages. This biological experiment, one of the longest on record, is unlikely ever to be repeated.

fixed intervals between vaccination of donors and vaccine transfer to recipients, so that the time when the vaccinal lymph was donated did not necessarily coincide with that of highest virus replication. The most virulent mutants, if present, would have been past their prime, already becoming thermally inactivated, whereas the less virulent, freshly hatched variants would dominate. This might explain why the virus progressively lost virulence. The old vaccinators became disenchanted with their procedure, and, rather than relying on natural incidences of cowpox, maintained the virus by serial passages in cows.

The selective pressures acting on rabies virus in Saigon were different. The decision to sacrifice a rabbit for supplying the seed necessary for the next transfer was made at a fixed time interval after the first symptoms were observed. The sooner the disease manifested itself, the sooner the spinal cords were harvested. This automatically adjusted the time of transfer to the properties of the virus, and selected a fast-replicating, virulent virus. After more than 1,500 passages the Saigon virus was still not 'fixed'; the repertoire of genetic variability governing the selected trait was not exhausted and microevolution was still in action, at least up to some point between the 1,500th and the 2,000th passage. By that time, the incubation period had shrunk from the initial 7 or 8 days to 4 days and the time to death from 11 or 12 days to 6 days. Between the 2,000th and the 3,080th passage no further changes were observed, but whether a few thousand additional passages would result in an even shorter incubation period will never be known.

The passage history of the virus kept in Saigon differs from that of the 'ancestral' strain kept in Paris. There the virus, also serially passed exclusively in rabbits, had only reached its 2,045th passage by 1964 and the average length of time between passages amounted to 14.5 days. In Saigon, the interval between passages over the entire period averaged 8.2 days. This difference is explained by the fact that in Paris longer intervals were possible, because the virus was refrigerated for a few days between passages. In Saigon refrigeration was probably not sufficiently reliable.

It is remarkable that these two lines of virus, with different passaging regimes, reached, around their respective 1,500th passage, exactly the same incubation period (6 days) and time to death (10 days). It would be interesting to compare, under strictly identical conditions (same breed, age, size of rabbits, same animal husbandry, same inoculation technique, same intensity of observation), the virulence (incubation length and time to death) of the latest (most recent) generations of the Saigon and Paris strains. The Paris experiment lasted longer (it probably lasts to this day, but serial passages are likely to have been replaced by keeping virus stocks in deep freeze), but in terms of passage numbers the Saigon series is more impressive. Assuming the two strains have been kept for the last 30–40 years in stable conditions, it might still be possible to make a direct, simultaneous comparison.

Rabies virus must be endowed with a set of genes, subject to mutations, which in certain configurations make for high virulence in a given host. This can go concomitantly with reduced virulence for another host. Pasteur felt that rabies serially passed in monkeys became less virulent for dogs. His hope that it would, at the same time, become less virulent for man was not fulfilled. Others have since been able to select virus strains of drastically reduced pathogenicity for dogs, suitable for use as live canine virus vaccines.

As a biological experiment of long duration the Saigon rabies series is unusual. A demanding technique applied and monitored unchanged over more than 60 years represents an effort unlikely ever to be repeated. It compares favourably with other purported long-lasting biological experiments, such as the 'immortal' line of chicken fibroblasts from Carrel's laboratory. To maintain the purity of a virus strain over so many passages is quite a feat, although it is probable that the rabbit, as a biological filter, was able to eliminate occasional contaminants. Infection by a genuine rabbit pathogen, capable of overwhelming the animal even faster than the adapted rabies virus, would have forced termination of the Saigon series. The technicians, locally hired and trained on the spot, must have been very reliable and competent, as must have been their teachers.

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Further reading

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meetings

NEW! Booking confirmation change

From 2007, confirmation of bookings for meetings will no longer be sent by post. A confirmation email will be issued for all bookings made.

Spring**07** | University of Manchester

26–29 March 2007 | 160th Meeting

Plenary Intracellular life of microbes

Programme booklet

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

Registration

Registration is through the SGM website. Anyone experiencing problems should contact the Meetings Office.

Registration fees per day (*incl. lunch refreshments, abstracts book, conference literature and disco*)

Earlybird (up to 23 February 2007)

Ordinary Members*	£40
Student/Technican Members*	£15
Non-members	£100
Retired/Honorary Members*	Free

Full (after 23 February 2007)

Ordinary Members	£50
Student/Technican Members	£25
Non-members	£110
Retired/Honorary Members	£10

Please note: to qualify for earlybird rates, 2007 membership fees must be paid by **23 February.*

Postgraduate Conference Grants

For full details, a form and allowances for travel see **www.sgm.ac.uk/grants/pg.cfm**

Offered Poster presentations

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

Microscene noticeboard

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

Special events

Monday 26 March

Welcome Reception, Manchester Museum of Science and Industry

Get to know your fellow delegates over a glass of wine on the first evening of the conference.

Tuesday 27 March

Society Dinner and disco

Cash bar until late.

Wednesday 28 March

PhD – What Next?

For early-career microbiologists only

Planning for your future? Come to this event and learn about various career options, followed by a buffet and wine. Entry is by ticket only, so ensure you tick the box on the booking form. If you are applying for a Postgraduate Conference Grant to attend the meeting, attending the workshop qualifies you for overnight accommodation on the Wednesday.

Autumn**07** | University of Edinburgh

3–6 September 2007 | 161st Meeting

Plenary Food, fluids, fingers, faeces and flies – food- and water-borne pathogens

3 & 4 September 2007

Organizers N. Dorrell, P.H. Everest, K. Grant, H.M. Lappin-Scott, R.A. Rastall, C.E.D. Rees & P. Wyn-Jones

Speakers

From farm to fork

H. Dalton London
R. Mandrell USA
C.E.R. Dodd Nottingham
C. Hill Cork

Food-borne disease

R. Adak Colindale
E. Duizer The Netherlands
C. Low Edinburgh
R. Glass USA

Water-borne disease

J. Rose USA
P. Hunter Norwich
K. Jones Lancaster
P. Wyn-Jones Aberystwyth

Intervention strategies

T. Brockelhurst Norwich
B. Marthi The Netherlands
L. De Vuyst Belgium
D.K.R. Karaolis USA

Hot topic symposium

with support from NERC

Post-genomic analysis of microbial function in the environment

Organizers A.M. Osborn, P.L. Bond & J. Snape

Other symposia/workshops

Mechanisms of diarrhoeal disease

Cells & Cell Surfaces / Microbial Infection Groups
Organizers P. Everest, B. Kenny & A.F. Cunningham

Anaerobe 2007 – Changing perceptions and patterns of anaerobic infection

Clinical Microbiology Group / Society for Anaerobic Microbiology
Organizers S. Patrick, M. Tunney & I.R. Poxton

Getting it right

Education & Training Group
Organizers L.M. Lawrance & M.J. Tully

Ecology of viruses

Environmental Microbiology / Virus Ecology Groups
Organizers D.A. Pearce, M. Clokie & N.H. Mann

Eukaryotic microbial pathogens, attack and counter attack

Eukaryotic Microbiology Group
Organizer A.S.H. Goldman

Monitoring in bioprocesses

Fermentation & Bioprocessing Group
Organizers B. McNeil & D. Papadopoulos

Workshop on molecular detection methods

Food & Beverages / Systematics & Evolution Groups
Organizer K. Grant

The physiology of non-growing microbes

Physiology, Biochemistry & Molecular Genetics Group
Organizer D.J. Clarke

Contact details of organizers are included in the meeting programme on the SGM website. Deadline for receipt of titles and abstracts for offered presentations: **4 May 2007**.

A poster to promote the meeting is enclosed with this issue. Please display it in your department.

Irish**Branch**

Biofilm: a system microbiology analysis

University of Limerick
19–20 April 2007
Organizer C. Adley

Microbial functions in response to the environment

Queen's University of Belfast
30–31 August 2007
Organizer J. McGrath

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

Other**Events**

French Microbiology Society / SGM

Nantes, France
30 May–1 June 2007

www.sfm.asso.fr

Third European Congress of Virology

Nürnberg, Germany
1–5 September 2007

www.eurovirology.org

Federation of Infection Societies Conference 2007

Cardiff
28–30 November 2007

www.fis2007.org.uk

Meetings on the web

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

Meetings organization

The SGM meetings programmes are organized by the committees of the special interest groups, co-ordinated by the Scientific Meetings Officer, **Professor Hilary Lappin-Scott**. Suggestions for topics for future symposia are always welcome. See p. 41 for contact details of Conveners.

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

Offered papers & posters

Many Groups organize sessions for the presentation of short oral papers or allow intercalated papers within their symposia. Offered posters are welcome at all Society meetings.

Offered posters

Each poster should be associated either with the Plenary topic or with a Group. The subject content of the latter should be relevant to the remit of a Group (see website for details); it does not have to relate to the topic of the Group Symposium taking place at a particular meeting. General Offered Posters will not be accepted.

Abstracts

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

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

It's a culture thing

With the good news that more practical microbiology is being carried out in schools these days, **John Grainger** offers some helpful advice on choosing and using the right microbial cultures.

P. Jandotte et al., Tours, France

There are signs of a resurgence in the teaching of microbiology in schools and colleges. One pleasing indicator is the strength of SGM initiatives, e.g. the schools membership scheme has more than 400 members and the basic practical microbiology course for teachers and technicians will pass the landmark of 50 courses and 1,000 delegates this year.

Also, there are developments on the syllabus front. The new 21st Century Science and other GCSE specifications contain a welcome increase in microbiology content. Inevitably, such developments draw many teachers and technicians into unfamiliar areas. Consequently, there are increasing demands for basic advice on how to meet the requirements for practical work, especially as practical aspects of specifications often receive inadequate support from the guidance provided.

As we welcome new entrants to the field and as much practical work involves working with pure cultures, it is timely, therefore, to revisit the questions of which cultures are suitable for use, who decides, where the information is published and how the cultures can be obtained. To start with, there is an approved list of cultures for use in schools and colleges that, given observation of good microbiological laboratory practice, present minimum risk and offer a valuable educational experience.

The risks

Pathogenic microbes are officially categorized according to risk, currently by the Advisory Group on Dangerous Pathogens (ACDP) in consultation with the Health and Safety Executive. The ACDP is an advisory committee of the Health and Safety Commission that also advises Health and Agriculture Ministers.

The categorization involves allocation of 'biological agents' to four Hazard Groups, i.e. (in decreasing order of risk): Group 4 (e.g. Ebola virus), Group 3 (e.g. the bacterium *Mycobacterium tuberculosis*), Group 2 (e.g. *Aspergillus fumigatus* a fungus causing a bronchial infection), and Group 1 for those considered unlikely to cause human disease. It is from Hazard Group 1 that the list of cultures considered suitable for use in schools and colleges is drawn.

Suitable cultures

Over the years, a succession of approved lists of cultures suitable for schools and colleges has been drawn up by government education ministries advised by groups with expertise in microbiological aspects of education and health and safety in school science. Developments in syllabuses and modifications to the ACDP categories occur from time to time in the light of improved knowledge and changes in legislation, and are taken into account. The current list* (2001) was the result of a widely representative safety conference convened by the Association for Science Education. Revisions included additions to the previous approved list and the introduction of helpful notes on the educational use and maintenance for each culture.

Using the approved list

It is essential to refer to the current list because it supercedes all previous lists. The current one consists of 28 bacteria, 40 fungi and 6 viruses; also listed are eight bacteria and a fungus now considered to be unsuitable. There is a general comment about the use of algae, protozoa and slime moulds, though none are named.

The approved list is not intended to be definitive and other cultures may be used if competent advice is obtained*. However, teachers wishing to use, at work levels L2 and L3 (levels that apply to practical microbiology work), cultures that are not listed as presenting minimal risk, must have had suitable training in microbiological techniques*.

Obtaining cultures

Recognized specialist suppliers* provide cultures chosen from the approved list, but for commercial reasons do not carry all those listed. They also stock ranges of algae, protozoa and slime moulds. There are differences between suppliers' lists, so it is useful to compare current catalogues – and ask why a particular culture is not on offer because a succession of enquiries may result in a change of policy. Allow plenty of time for delivery (read the small print) and for preparation of cultures so that they are growing actively for class use.

For DIY enthusiasts

In addition to working with pure cultures, there is also a place for investigations using natural materials and commercial products. Here are a few pointers to some straightforward activities:

> Observe successions of protozoa and algae developing in a hay infusion (hay + pond/lake water) at ambient temperature (maximum 25 °C) weekly using a ×10 objective lens.
>
> Look for bacteria in yoghurt by staining a smear of natural yoghurt (read the label) by Gram's method and examining with, preferably, an oil immersion objective lens.
>
> Show the effect of heat on bacterial survival by preparing streak plates on nutrient agar from soil suspensions that have been heated at a range of temperatures, e.g. 60, 80, 100 and 121 °C, then incubate. The plate from an unheated control sample may show zones of inhibition of growth (antibiotic production?).
>
> Show the presence of microbes on healthy leaves by pressing a leaf on the surface of agar plates (nutrient agar for bacteria; malt extract agar or dextrose potato agar for fungi). Remove the leaf and incubate. Discuss the relevance to composting and ensilage.

DIY enthusiasts might also consider it convenient to maintain a laboratory collection of cultures instead of purchasing a new culture each time one is needed.

**Details available from, e.g. ASE, CLEAPSS, MiSAC, SGM and SSERC (see Further information below).*

John Grainger
MiSAC Chairman, Visiting Fellow at the University of Reading and co-deliverer of SGM's basic practical microbiology courses for teachers and technicians (e j.m.grainger@reading.ac.uk)

Further information

Free from SGM (education@sgm.ac.uk):

Basic Practical Microbiology: a Manual (2006). SGM. ISBN 0-95368-383-4

Practical Microbiology for Secondary Schools (2002). SGM. ISBN 0-95368-382-6

From ASE Bookshop (www.ase.org.uk/htm/book_store/):

Topics in Safety: Topic 15 (2001), 3rd edn. ASE. ISBN 0-86357-316-9 (*£18 to ASE members; £30 to non-members*)

Websites

Association for Science Education (ASE) – www.ase.org.uk

CLEAPSS – www.cleapss.org.uk

Microbiology in Schools Advisory Committee (MiSAC) – www.microbiologyonline.org.uk/misac

Scottish Schools Equipment Research Centre (SSERC) – www.sserc.org.uk

SGM – www.microbiologyonline.org.uk

In brief

Curriculum changes in England, Wales & Northern Ireland

GCSE science

The criteria have been revised by the Qualifications and Curriculum Authority (QCA) and each awarding body has created a new suite of courses. These aim to offer a more contemporary approach to science teaching, with greater flexibility and choice for students. Teaching of the new courses began in September. The good news is that microbiology has a higher profile.

www.qca.org.uk/12265_14491.html

Post-16 science

Changes are also in the pipeline for post-16 students and new AS- and A-level science courses will be taught from September 2008. With QCA criteria in place, the awarding bodies are currently devising new courses. The aim is to offer more contemporary content and foster the development of investigative skills. In biology, the course specifications must ensure there is an appropriate balance between animal biology, plant biology and microbiology. Students will be learning more about micro-organisms than before.

www.qca.org.uk/16182.html

Specialized diploma

As part of its 11–19 reform programme, the government is introducing a new employer-led Specialist Diploma. Originally science was left off the list of subjects, but with GNVQ science being phased out from 2007 and following demands from industry, the QCA has been investigating the possibility of having a diploma in science. This has included a consultation to which SGM responded. With the new GCSE in Applied Science just beginning to take off, many in the science community feel that the new diploma would be an unnecessary qualification that adds to the burden of educators of this age group.

www.qca.org.uk/17112.html

Chemistry for non-specialists

The Royal Society of Chemistry (RSC), supported by GlaxoSmithKline and the DfES, is organizing a new teacher training initiative. A 3-year programme of courses has been designed to raise the confidence and expertise of non-specialists teaching KS3 or KS4 chemistry in UK secondary schools. The charge for each 4-day course is only £120 + VAT. For detailed information about the courses and their venues: www.rsc.org/chemnonspec

Book reviews

Healthy Kids: Illness and Injury

S. Goulding, Evans (2006), £5.99, pp. 32, ISBN 1-84234-319-X

Covering topics from coughs and colds to cancer, this is an attractive format and should be of interest to 7- to 11-year-olds. Unfortunately, it is inconsistent in the balance between keeping it simple and using medical or scientific terms. We are told that colds are caused by viruses, so can't be treated with antibiotics, but in the glossary that antibiotics kill 'germs'. The definition of diarrhoea as 'your stool is runny' is not much help to most children I know. Also mucus is misspelt as mucous (almost) throughout. I'm afraid this book tries to cover too much ground and just misses the mark.

Healthy Kids: Taking Care of Your Teeth

S. Goulding, Evans (2006), £5.99, pp. 32, ISBN 1-84234-316-5

I love the photographs in this delightful book, showing lots of toothy smiles. There is plenty of sensible advice about tooth care, and information about what dentists do, all helped along by interesting asides such as the number of teeth a giant armadillo has. The text is written in straightforward language and the layout makes it easy to dip into. I would recommend this book for children around 7–11 years old.

Lucinda Hall, Queen Mary, University of London

Lords investigate schools science teaching

Pupils in England find science A-levels too difficult and other subjects more 'funky'.

This was the conclusion of the recent report of the House of Lords Select Committee inquiry into Science Teaching in Schools. The Committee noted that one reason why the number of pupils taking A-level sciences had declined was simply fashion, with competition from new options such as psychology and media studies. A more fundamental problem was that traditional science subjects are perceived by pupils as more difficult, a perception that the Lords felt was indeed backed up by evidence from A-level scores. The problems were compounded by school league tables, poor labs, unfounded health and safety fears and a shortage of specialist teachers. The stress on test results had created a culture of '*teaching to the test*', forcing teachers into '*narrow and uninspiring methods of teaching*'. The report also expressed concern that the new 'light touch' Ofsted inspections would mean there would be no future evidence base on the quality of science teaching in schools.

The Peers recommended a broadening of the A-level curriculum to ensure that students do not over-specialize before they have seen the merits of pursuing science. They felt that longer-term incentives were essential to attract science teachers into the profession and that all teachers should undergo mandatory subject-specific continuing professional development each year, with additional money allocated to pay for supply cover. They also called for the Government to improve the quality of careers advice in schools as a matter of urgency.

The SGM submitted written evidence to the inquiry and Sue Assinder, SGM Education Officer, gave oral evidence as Chair of the Biosciences Federation Education Committee. The report specifically notes the concerns expressed by the SGM that teachers do not always know where to find authoritative health and safety advice. It urges the Government to act to secure the future of practical science in schools, including a central website to address health and safety fears.

Sue Assinder
SGM Education Officer

Further reading

House of Lords Science and Technology Committee (2006). *Science Teaching in Schools: Report with Evidence. 10th Report of Session 2005–06*. London: The Stationery Office.

www.parliament.uk/parliamentary_committees/lords_s_t_select/teaching.cfm

GlaxoSmithKline science fair at Heathside School, Weybridge

For two mornings in October, GlaxoSmithKline (GSK) Consumer Healthcare at Weybridge ran a science fair at Heathside School in Weybridge for over 200 year 10 students.

We ran the fair with the broad aim of trying to show the students that a science education or career doesn't necessarily mean you end up turning into Prof. Pat Pending from the 'Wacky Races'. People with science degrees and training from across the GSK Consumer Healthcare business all contributed to the fair, showing how they were using their science to do their job, even though it might not look like science now. Some of this was encapsulated in a small booklet containing education and career biographies of many of the 'scientists' involved in the fair, and was given to each student.

The fair consisted of a number of sections that the students travelled round and visited for 15–40 minutes, depending on the section (a lesson in logistics). At each point the students were given demonstrations and then the chance for some hands-on experience and the opportunity to talk to the scientists.

The microbiologists demonstrated a variety of methods to support microbiological claims on products. We showed the students different bacteria under the microscope and normal hand 'flora' on a large agar plate (prompting many students to wipe their hands on something), and talked to them about our different career paths and the opportunities there are to be able to work outside the laboratory. SGM kindly supplied some excellent posters on various aspects of microbiology (which the school has kept for science classes), careers leaflets and booklets, as well as some very attractive 'giveaways' (promoting www.biocareers.org.uk and www.microbiologyonline.org.uk) which went down very well!

▼ Year 10 pupils at the GSK science fair in October. *Kevin Charman*

Formulation scientists gave insights into making products, ensuring products have the correct appearance, feel and function. This led into sensory science and how the senses of taste, smell and texture are important, particularly in oral products. Some strange coloured sweets with unexpected flavours were found at this session – fortunately no earwax flavour!

A breathalyser from the analytical scientists demonstrated factors such as sensitivity and specificity, and being able to quantify an analyte. With an artist in the innovation and marketing session the students' ideas generated from a product brief were brought to life, ending up with concepts showing how their ideas could turn into a finished product.

The process engineering group demonstrated some equipment and design considerations in putting the stripes into toothpaste (in school colours, of course). There was even time for 'dressing-up' for Good Manufacturing Practice. Health and Safety went off with a bang (literally, but safely) when illustrating pyrotechnically some of the dangers of powders and dusts if not handled correctly.

The response from the students was excellent, with questions and interest at all the sections. The feedback from the teachers was that there was a lot of positive talk and enthusiasm about the fair and they look forward to doing it again next year with a new set of potential scientists!

Kevin Charman
Microbiologist, GSK Consumer Health R&D
(e kevin.m.charman@gsk.com)

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

Careers in medical microbiology

There are two well-defined career paths for medical microbiologists in the public sector, one via the Biomedical Scientist (BMS) route and the other via the Clinical Scientist route. Anyone wishing to work in either of these roles must be state-registered with the Health Professions Council (HPC).

Biomedical Scientists

Biomedical Scientists usually work in NHS trust and Health Protection Agency (HPA) laboratories, investigating samples of body tissue and fluids to diagnose disease, monitor treatments or track disease outbreaks. They also find work in other organizations, including the National Blood Authority, pharmaceutical industry, university, MRC and forensic labs. Long-term career prospects include laboratory management, research and teaching. Entry is restricted to graduates, usually with degrees that have been validated by the Institute of Biomedical Science (IBMS). It is possible to enter the profession with a related bioscience degree, but the Institute assesses course content and it is sometimes necessary to undertake additional study. The IBMS awards a certificate of competence, following a period of in-service training in an approved laboratory, which is required for state registration.

Clinical Scientists

Clinical Scientists generally work in diagnostic laboratories and pathology departments in large hospitals and medical schools. In addition to laboratory-based research, they give scientific and clinical advice that has a direct bearing on the management of patients. Training towards state registration is overseen by the Association of Clinical Microbiologists and can be via one of two pathways:

a 4-year structured training which includes a Grade A Clinical Scientist course followed by one or two years experience in the laboratory whilst still under supervision. Recruitment to this scheme begins in November every year and the closing date for applications is in February. Competition is very stiff and there is only a handful of microbiology training placements each year.

a 6-year route which concentrates on achieving state registration by experience. Applicants must gather evidence to support their case for registration.

The Health Protection Agency is also a major employer of clinical microbiologists, some of whom work in reference laboratories or as epidemiologists. Work focuses on disease diagnosis, treatment and surveillance; clinical scientists often collaborate closely with health care professionals. There is some opportunity to carry out research and development projects in the specialisms of bacteriology, virology, mycology and parasitology.

Medical-related research

Work in clinical microbiology is not restricted to state-registered Biomedical or Clinical Scientists. There are opportunities for PhD and postdoctoral research posts in HPA, university, MRC and hospital laboratories. These are usually short-term contracts, but the experience can be used to work towards state registration as a Clinical Scientist by the 6-year route.

If you are studying for a BSc, MSc or coming to the end of a PhD research project in medical microbiology, you may well be considering your career options in this field. Microbiologists are employed in a range of roles within the healthcare sector; here is a quick guide to help pick your way through the different career pathways.

Microbiology as a clinical specialty

All newly qualified doctors receive training in microbiology during their foundation training. There are also opportunities for further training in this specialty. The Royal College of Pathologists oversees this training. Day-to-day work of medical microbiologists ranges from individual case management in any of the clinical disciplines through to laboratory-based work with non-clinical staff and liaising with management.

Further information

www.abpi.org
Association of British Pharmaceutical Industry

www.aclinmicrobiol.org.uk
Association of Clinical Microbiologists

www.careerscene.com
Job vacancies in biomedical science

www.hpcuk.org
Health Professions Council

www.hpa.org.uk
Health Protection Agency

www.ibms.org
Institute of Biomedical Science

www.mrc.ac.uk
Medical Research Council

www.nhscareers.nhs.uk
Health Service Careers

www.nhsclinicalscientists.info
Clinical Scientists' Recruitment

www.rcpath.org
Royal College of Pathologists

A job in... Medical microbiology

Profile

Name Matt Scarborough
Present occupation Specialist Registrar in Infectious Disease and Microbiology, John Radcliffe Hospital, Oxford
Education Queen's University Belfast, BSc Hons, MBBCh

Q What attracted you to microbiology as a specialty?

Microbiology offers the combination of interesting, interested people with fascinating and hugely satisfying medical practice. To tell the truth, microbiology was far from being one of my strengths at university and I don't remember considering it as a career option at that time. As part of an SHO (postgraduate training) rotation, I worked in genitourinary medicine for 6 months where I developed an interest in infection and particularly HIV.

Q What was your next step?

Since I was also keen to travel, I developed a research project that took me to Malawi for 3 years. Whilst there, I worked with a whole load of folk, many of whom were a little unconventional, had often travelled a great deal and who had a tangible passion for their work. Similarly, the patients I met often had intriguing tales and, generally, presented with definable and often completely curable diseases.

Q Can you describe a typical day?

There isn't really a typical day. My current post rotates between clinical attachments and microbiology. This morning, I started in the lab discussing the identification of some bugs with the biomedical scientists and deciding on what further tests we might do to help the clinicians manage the patients. I then spent an hour looking through all the culture results from yesterday's samples. From these I 'cherry-picked' the cases where I thought our input might help the physicians. I spent most of the afternoon seeing these patients on the ward, as well as several more complex cases referred to us by the ward physicians. Later in the day, I helped set up a small part of a research project on the control of hospital acquired infections (such as MRSA and *Clostridium difficile*). Today's work was diverse, enjoyable and hugely educational. Microbiology is very much a team specialty and what we learn is, in the main, by true apprenticeship.

▲ Matt with two young patients in Malawi. *Matt Scarborough*

Oh yes – and I happen to be on call tonight; I've just dealt with an enquiry about a possible rabies exposure in a patient retuning from Myanmar. I wonder what'll be next?

Q How do you see your future?

In the longer term, I suspect that I'll travel again, maybe to the Far East, to combine clinical service and research in a developing country. I have no idea where it might lead but I know for sure that I'll meet some wonderful people, treat some fascinating diseases and have great fun in doing so.

hotoffthepress

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

A soapy solution to HIV?

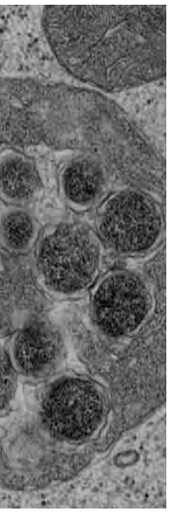
Roner, M.R., Sprayberry, J., Spinks, M. & Dhanji, S. (2007). Antiviral activity obtained from aqueous extracts of the Chilean soapbark tree (*Quillaja saponaria* Molina). *J Gen Virol* **88**, 275–285.

The Chilean soapbark tree (*Quillaja saponaria*) is a small evergreen tree found in Chile and Peru. Extracts from the bark are used as soap because the saponin chemicals within it act as detergents. They are used in the food and beverages industry in the USA to make frothy foams, and even to create the foam in some fire extinguishers. *Quillaja* extracts are also a traditional medicine in South America for some chest problems, while in modern medicine, purified *Quillaja* saponins are used in vaccines to enhance their protective activity.

Researchers in Texas have been investigating a new role for these triterpenoid saponins as antiviral agents that appear to work through novel interactions with both the virus and host cells. Viruses can only replicate within living cells, so antiviral agents can be effective by preventing viruses attaching to cells or interfering with steps within the viral replication cycle. The researchers tested whether *Quillaja* saponins reduced infection of human or animal cell cultures by six viruses, including HIV and herpes simplex virus. Concentrations of *Quillaja* saponins below 1.0 mg ml^{-1} did not affect the growth of the cells, but had direct antiviral activity at a 10-fold lower concentration for five of the six viruses.

Much more interestingly, treatment of the cell cultures with *Quillaja* saponins for an hour made the cells very resistant to viral infection for up to 16 hours after the saponins were washed away. Incubation in *Quillaja* extract at levels as low as 0.0001 mg ml^{-1} completely blocked the binding of HIV to the cells, despite the virus remaining fully infectious. Less than 0.25 % of the virus attached to the cells and then caused only 4 % of the expected level of active viral infection.

The most likely mechanism for this protection against such a wide range of viruses is through modification of surface features that the viruses use to recognize and enter cells. The fact that the *Quillaja* extract provided such effective protection in laboratory tests on cell cultures prompted the researchers to suggest that it is a good candidate for use within spermicidal agents to protect against sexually transmitted viruses. The fact that *Quillaja* extracts are approved for use in food and beverages in the USA, indicating their harmless nature to people, is an important first step towards this use.



Star Wars fantasy comes true!

Sassera, D., Beninati, T., Bandi, C., Bouman, E.A.P., Sacchi, L., Fabbi, M. & Lo, N. (2006). '*Candidatus* Midichloria mitochondrii', an endosymbiont of the tick *Ixodes ricinus* with a unique intramitochondrial lifestyle. *Int J Syst Evol Microbiol* **56**, 2535–2540.

A character from the *Star Wars* films has been discovered inside ticks on planet Earth. Or, rather, researchers have named a remarkable new genus of bacteria after the midichlorians, imagined by George Lucas as microscopic creatures residing within cells and able to 'communicate with the Force'. The new bacterium, '*Candidatus* Midichloria mitochondrii', is the only bacterium known to be able to invade and live inside mitochondria, the intracellular organelles that generate energy to keep cells alive. The bacteria were identified in a collaboration between researchers from Australia, Italy and the Czech Republic who decided that naming them after the midichlorians was particularly appropriate.

The researchers examined cells from the blood-sucking tick *Ixodes ricinus* by electron microscopy and they were struck by the sight of up to 20 bacteria packed into the mitochondria of ovaries in all the females. The bacteria were only found in the ovaries of the female ticks. Even though large numbers of mitochondria were invaded and destroyed by the bacteria, the eggs of the infected ticks appeared to develop normally. '*Candidatus* M. mitochondrii' proved impossible to grow in the laboratory, so the researchers used molecular biology methods to work out the sequences of two of the bacterial genes. These turned out to be a good match to sequences from several other unculturable bacteria, but were sufficiently different to show that the researchers had found a new candidate genus and maybe even a new family of bacteria. When male ticks were tested, 44 % were found to contain these bacteria, even though nothing was visible on electron microscope images.

I. ricinus ticks are notorious for transmitting Lyme disease and other human and animal pathogens. The researchers suggest that '*Candidatus* M. mitochondrii' may interact with pathogens transmitted by the ticks. Its presence in the ovaries of all female *I. ricinus* ticks suggests it may have a role in their biology and the discovery of the symbiont adds to the information about the bacterial community associated with this arthropod.

Mobile genes and meningitis

Dunning Hotopp, J.C., Grifantini, R., Kumar, N. & 9 other authors (2006). Comparative genomics of *Neisseria meningitidis*: core genome, islands of horizontal transfer and pathogen-specific genes. *Microbiology* **152**, 3733–3749.

Most *Neisseria* species live harmlessly on warm-blooded animals, including people. *N. meningitidis* is the best known species because it can travel from inside the nose to the bloodstream and cross the blood–brain barrier. Some strains of *N. meningitidis* cause epidemic bacterial meningitis that can rapidly affect large numbers of people who live in close contact. However, up to 20 % of people carry *N. meningitidis* in their upper respiratory tract and remain perfectly healthy. Understanding the nature of potentially pathogenic strains is therefore important. It is also a challenge because of the way that this species can change its complement of genes. It has a natural ability to take up DNA from the environment and incorporate it into its own genetic structure.

The complete genome sequences of three strains of *N. meningitidis* are available. Comparative genome hybridization was used to examine 53 *Neisseria* isolates, representing the whole range of types within *N. meningitidis*, as well as two strains of *N. gonorrhoeae*, which causes gonorrhoea, and three non-pathogenic species. The technique uses microarrays containing DNA designed to match each of the 2,158 genes within one sequenced *N. meningitidis* strain along with additional DNA representing unique regions from other *Neisseria* genome sequences. DNA extracted from each of the *Neisseria* isolates was then tested with this microarray to see which genes were in each isolate.

The researchers identified the core *N. meningitidis* genome from the genes present in all the strains. The data also showed that *N. meningitidis* strains had acquired groups of genes, called genetic islands, from *N. gonorrhoeae*, non-pathogenic *Neisseria* species and other bacterial species that colonize the respiratory tract, as well as exchanging them between themselves. The results suggested that some of these transfers might have involved bacterial viruses or other mechanisms that make DNA more mobile. It was also very clear that there is an efficient system to restrict the types of DNA that could be taken up by *N. meningitidis*. The results also helped to characterize genes that determine cell-surface structure and to identify some aspects of metabolism that may be essential for survival within human cells. However, one of the most important outcomes of this study is the large amount of data on which genes are present or absent from which strains – this will be valuable to all researchers trying to understand the nature of pathogenicity in *N. meningitidis*.

▶ Acridine orange/DAPI-stained human macrophage containing *Citrobacter koseri*. *S. Townsend, Nottingham Trent University*

◀ '*Candidatus* Midichloria mitochondrii' inside the mitochondria of the oocytes of the tick *Ixodes ricinus*. *Luciano Sacchi, University of Pavia, Italy*

A 'tail' about brain abscess formation

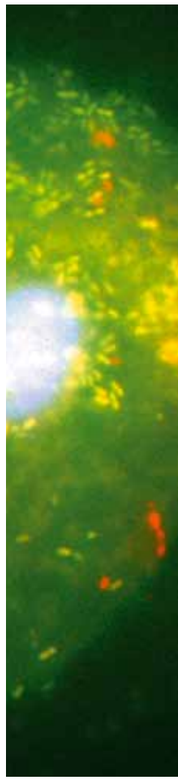
Townsend, S.M., Gonzales-Gomez I. & Badger, J.L. (2006). *fliP* influences *Citrobacter koseri* macrophage uptake, cytokine expression and brain abscess formation in the neonatal rat. *J Med Microbiol* **55**, 1631–1640.

The bacterium *Citrobacter koseri* can cause very serious infections, particularly in the brain of new-born and young children. Most of these meningitis cases occur out of the blue with no obvious source of infection. Around a third of infected infants die and many of the survivors have severe neurological damage. This is because the infection results in intense inflammation of the brain, frequently causing abscesses that do not respond to antibiotic therapy. In fact, *C. koseri* infections are more likely to cause brain abscesses than any other bacterial species. The bacterial cells survive and grow within macrophages, cells of the immune system that are supposed to engulf and digest pathogens at an early stage in the immune response. A better understanding of the disease process would certainly help to develop improved treatments.

Researchers have now identified one bacterial gene with a role in the uptake and survival of *C. koseri* inside macrophages. They tested the ability of mutant strains of *C. koseri* to survive with macrophages, and found seven mutants that did not survive as well as the wild-type, an indication that the mutation had occurred within an important character. They evaluated each mutant in cell cultures and found differences in their abilities to enter and survive within macrophages. Despite these differences five had the same effects on neonate rats as the wild-type, but one was no longer lethal since the bacteria were very efficiently removed by the immune system without any signs of brain damage.

The seventh mutant (SMT350) was much more virulent, killing all the rats within only 2–3 days, before brain abscesses could develop, and leaving most of the bacteria outside the macrophages. The researchers worked out that this mutant lacked a protein essential for flagella, the surface structures that bacteria use to propel themselves through liquids, and tests showed that SMT350 were indeed unable to move. This fitted with information from other research groups that flagella seem to be important for bacteria to invade animal cells. It also hinted that the flagella might conceal a toxic factor on the bacterial surface that was exposed in its absence.

Macrophages produce interleukin-12 and -10 as signals to the immune system to induce resistance to intracellular infections. Each interleukin induces a different type of response and when the researchers measured their levels, it appeared that the *C. koseri* flagellum, rather than any other bacterial cell component, had a dramatic immunosuppressive effect. This may be why the infection persists so effectively and causes brain abscesses. The possibility that the flagellum plays a key role in determining the course of this infection is a significant step forward in understanding this disease.



Handbags and gladrags

Recently **Jo Verran** got caught up in a news story. Here is how she became a media star…

In my microbiological career to date, I have tended to avoid contact with the media. Germs always seem to get such a bad press – nothing is ever good news and no matter what the story, the main question would be '*so, will it kill me?*' Having lived happily and grubbily with microbes for so long, I didn't want to be alarmist or cornered into making a ridiculous quote.

However, in August, I was asked to comment on a study about mobile phone contamination, since they '*had more germs than a toilet seat*'. Feeling sorry as ever for the much maligned toilet seat, and remembering the key message from the SGM media training course I attended – if you don't do it, someone else will – I finally entered the world of the press.

My quote was as inoffensive as possible: '*Mobile phones are stored in bags or pockets, are handled frequently and held close to the face. In other words, they come into contact with more parts of our body, and a wider range of bacteria than toilet seats*'. The *Daily Mail* ran the story on page 3. My statement had been extended a little, and the context was also somewhat different from what I had intended… '*phones crawling with potentially lethal bacteria*', '*S. aureus, causing illnesses from pimples and boils to pneumonia and meningitis, and a close relative of the superbug MRSA*'. I was immediately besieged by an interested media. I felt I had to explain what had been written, rationalizing the statements, emphasizing the hygiene aspects of mobile phone use, and mentioning cross-contamination, so I 'ran' with the story.

◀ Jo during her GMTV interview with Lorraine Kelly.

I was on Radio 5 Live, Radio 1Xtra, Radio One and 13 BBC local radio stations. I redirected enquiries that I was too busy to handle to SGM for others to deal with. I believe Hugh Pennington was on Radio 5 Live later in the day. For local radio, I was shut in a room at the BBC with some headphones and a glass of water, fielding questions as the stations came on line during a 2 hour period. Some of the broadcasts were live, others were recorded and edited. Some of the interviews were serious, some dismissive, others light-hearted. Radio Cornwall told their listeners (including my family back home) that I was a 'local girl'. I even managed a few laughs when I remarked, in defence of toilet seats, that they only came into contact with one part of the body, and that was not (usually) the face!

Granada TV filmed a short clip in the labs for the teatime show, and I was interviewed live at lunch! It was OK. I felt that the main thing was not to over-commit to any statement about people being killed by mobile phones! Exhausted by the end of the day, and after a sleepless night waiting for the mobile phone companies to chase me, I went to work very early next day to avoid any TV cameras and journalists (of course there weren't any!). However, via the net, the news had gone global. CBS, ABC, CNN, French and Belgian TV and radio stations wanted to talk about mobile phones. I went on holiday. The story quietly disappeared.

On return from holiday, queries from magazines awaited: *Marie Claire*, *Readers' Digest*, etc. Long forgotten colleagues made contact. An old schoolfriend read about me in Strasbourg. A research group looking at the cross-infection potential of mobile phones was also in touch, along with companies wanting to disinfect phones.

A couple of months later, I had also become the new 'how dirty is your mobile/handbag/makeup?' expert, and appeared on GMTV with Lorraine Kelly (and met Ashley from X-factor!). We looked at contamination of a few handbags, and I was again filmed in the lab as well as being on live television. The brief slots were very tightly controlled, the intention being that specific messages were conveyed (discard old makeup, avoid putting bags on toilet floors, ensure re-used water bottles are cleaned, etc.). I had to wear a lab coat, so that I looked like a scientist, and I also had to stand up, which made me look like a dwarf as everyone else was tall. Lorraine Kelly's interview style was very informal, but also so helpful, in that she made it easy for me to remember to address all the key points.

My final media encounter focused more specifically on makeup bags, for a style programme on local satellite TV 'Channel M'. The entire interview was filmed in the lab, and the *Manchester Evening News* ran an accompanying article.

So, after the initial overflow of mobile-related adrenalin, overall I felt that the media experience hadn't been too bad. My reputation hadn't been destroyed. My university was thrilled with the exposure. I felt more confident about talking to the press, and had realized I was able to interview live on TV or radio. I had helped promote microbiology to a wider audience and got people talking about it. Don't know what I was so worried about!

Joanna Verran is Convener of the SGM Education & Training Group, as well as Professor of Microbiology at Manchester Metropolitan University (e j.verran@mmu.ac.uk).

The SGM holds occasional one-day media training courses for members, to help them deal with the press and to promote their work more widely. Please contact the External Relations Office if you are interested in attending one (e pa@sgm.ac.uk).

Science and the Parliament 2006 – a manifesto for science

On 1 November 2006, the Royal Society of Chemistry held its annual '*Science and the Parliament*' event at Our Dynamic Earth, opposite the Scottish Parliament building in Edinburgh.

▼ Professor Anne Glover delivering her address at the *Science and the Parliament 2006* event. *Royal Society of Chemistry*

The event, which attracted hundreds of participants from across the science and political communities, strives to raise awareness of science issues to MPs and civil servants working in the Scottish Parliament. With elections taking place next year, the aim of the day was to look at key scientific issues that may face those elected next May.

The event started with addresses from a host of first class speakers, including RSC President, Professor Jim Feast, and Deputy First Minister and Science Minister, Nicol Stephen MSP, who appealed to the delegates to make science more enjoyable for children.

The Chief Scientific Adviser for Scotland, Professor Anne Glover, also addressed the delegates and spoke passionately about the 'enviable history of scientific achievements in Scotland'. She went on to highlight the role that science plays in all aspects of the Scottish Executive's work. Professor Glover, from the University of Aberdeen, is a long-standing member of the Society and was an elected member of SGM Council from 1995 to 1998.

Breakout sessions followed the presentations, which addressed four policy areas: enterprise and life-long learning, education, environment and energy. A representative MSP from each of the political parties also spoke of their party's policies for science.

The day ended with an evening reception and exhibition. With hand hygiene in relation to hospital-acquired infections in particular, but also food production, likely to remain a burning issue for any parliament, SGM was among the many exhibitors in attendance with a topical display

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

Science and the Parliament 2006 was organized by the Royal Society of Chemistry in association with the BA, Campaign for Science and Engineering, Institute of Biology, Institute of Physics, Royal Society of Edinburgh, Association of Science Education, Society of Chemical Industry, SCOTETA (Engineering & Technology Association – Scotland), and SGM, of course!

Faye Stokes
Public Affairs Administrator

Helping the Lords (and Ladies)


Photodisc

The External Relations Office has an active programme of keeping the profile of microbiology high to members of both houses of parliament, policymakers, opinion-formers and their advisory services. This includes the regular distribution of selected issues of *Microbiology Today*, briefings on topical issues in microbiology and other relevant publications, placing targeted advertisements in parliamentary publications and holding occasional presentations in national and regional parliaments. We also offer impartial information on any microbiology topic on request. This is provided through our network of over 2,000 specialists who have agreed to help with enquiries.

SGM is clearly now becoming an accepted one-stop shop for parliamentarians wishing to raise particular microbiological issues and seeking the facts to back them up. A good example recently concerned the somewhat unlikely topic of chewing gum.

Sticking to the point

On 31 October Lord Selsdon asked a Parliamentary Question in the House of Lords, '*To ask Her Majesty's Government what steps they will take to reduce the level of urban pollution caused by the illegal depositing of used chewing gum on pavements and streets.*'

What has this got to do with microbiology? Lord Selsdon wanted to find out what the health hazards were from deposited chewing gum – did it harbour pathogens, could it transmit disease; if so, how long would so-called 'gum turds' be a danger to the public? He phoned the SGM to find out. We were able to put him in touch with experts who could answer all these queries. The question provoked a good deal of debate in the Lords, as recorded in *Hansard*, and in writing to thank us for the help, Lord Selsdon was delighted to say that the response had been covered on Radio 4 and by BBC Online. As a result of highlighting this issue he hopes that the Government will fund research that will lead to safer deposition of used gum by the public.

Baroness Masham of Ilton also welcomes SGM information and recently sent us a copy of *Hansard* which includes the discussion of her question '*What actions are [Her Majesty's Government] taking to prevent the spread of* Clostridium difficile *in hospitals and in the community?*'

Anyone wishing to receive a copy of the SGM briefing on *C. difficile* should contact **pa@sgm.ac.uk**

Janet Hurst & Faye Stokes
External Relations Office

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council**06–07**

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reviews

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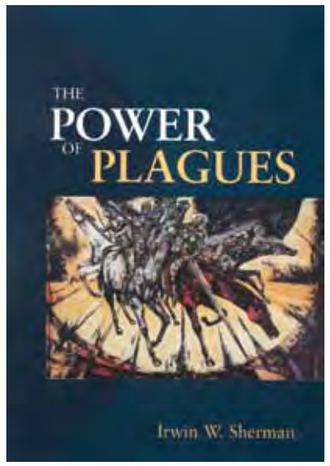

The Power of Plagues

By Irwin W. Sherman
Published by ASM (2006)
US$39.95 pp. 431
ISBN 1-55581-356-9

Plagues – severe outbreaks of epidemic diseases – have shaped history, continue to surprise and challenge us despite recent huge advances in science and medicine, and will bedevil humankind for as long as it exists. Where other books on plagues have tended to focus on their historical impact, in this volume biologist Irwin Sherman also considers them from a scientific perspective. He provides a potted history of medical microbiology and describes the work of the pioneering scientists who made the discoveries that led to our understanding of infectious disease and pathogens, and who developed methods of control.

Whilst concentrating on infections, the book also covers epidemic diseases that proved not to be caused by 'germs', but by other creatures such as worms and insects, and factors like vitamin deficiencies.

There is an enormous amount of fascinating information packed into this book. The author has chosen not to treat his material chronologically, but to divide it into chapters on topics, some of which cover individual diseases, selected for their value in providing lessons in medical microbiology or other branches of science. Each plague is described in its historical context, written in a story form that captures the reader's attention, as well as giving the clinical details of the disease, how the causative agent was discovered and what can be done to prevent and treat it. Important findings relating to the particular plague that broadened our general knowledge are also included.

This structuring means that each chapter stands alone and need not be read in the sequence presented. However, those just dipping into the book could miss a lot; it is necessary to read it right through to gain the full picture. For example, the spontaneous generation theory is covered in the chapter on cholera, because it was disproved at around the time in the late 19th century that an epidemic of the disease was raging. Variolation and vaccination are unsurprisingly included along with the smallpox story, yet a later chapter 'preventing plagues' covers the immune system (by analogy to a medieval castle!). If the reader skips the last paragraph in the preface that recommends reading chapters 1, 2, 10 and 11 first, especially if he or she has no scientific background, because these explain the basic principles that make it easier to understand the rest, then they could end up somewhat confused.

Despite this drawback, it is worth persevering to navigate the book because there is so much to learn! Humans were healthy for millennia when they were hunter-gatherers. Then evolutionary and climate changes led to the formation of settlements, which affected the patterns of disease. Changes in diet to meat eating and the domestication of animals exposed hominids to parasites and it was down hill from then on. In antiquity all diseases were called plagues (from the Latin 'plaga' meaning 'to strike a blow that wounds'). Smallpox and malaria came early, but the causes of many severe epidemics described by ancient writers and confirmed by archaeological evidence, cannot be deduced today. Some diseases, for example, bubonic plague, kept coming back with devastating effect on the world's population, yet remained dormant for centuries in between outbreaks.

This book does not just dwell on the past; it takes each disease up to the present day and also includes sections on current plagues like AIDS, resurgent diseases such as TB and puzzles such as spongiform encephalopathies. The reader is also left in no doubt that there are many plagues still to come.

This interesting and thought-provoking book is an excellent read. It is also illustrated throughout with appropriate line drawings, photographs and other illustrations.

***Janet Hurst**, SGM*

Exposure: A Guide to Sources of Infections

By D. Sturchler
Published by ASM (2006)
US$129.95 pp. 910
ISBN 1-55581-376-3

The rationale for this book is that, given that exposure is the first step in infection, exposure history is an important part of the diagnosis of infectious diseases. This aspect is rarely dealt with in detail in traditional microbiology text books, but this impressive review of the ways in which humans can be exposed to infectious agents redresses the situation. Coverage is comprehensive, detailing agents from prions to parasites and exposure routes via natural and man-made environments as well as via other living organisms (human and animal). The subject has been very thoroughly researched – the author says he has reviewed more than 13,000 publications, 8,430 of which are cited. I like the different ways you can use this book – by turning to the sections on the exposure route or the agent, or by using the comprehensive index. Overall, a useful reference book and good value for money.

***Pat Goodwin**, The Wellcome Trust*

Rinderpest and Peste des Petits Ruminants

Edited by T. Barrett, P.P. Pastoret & W.P. Taylor
Published by Elsevier Academic Press (2005)
£56.99/US$89.95 pp. 288
ISBN 0-12088-385-6

This is a good monograph; no, it is an excellent monograph. It is one within the series entitled *Biology of Animal Infections* that have emanated from the Institute for Animal Health. It is not surprising that the two ruminant morbilliviruses (Rinderpest and Peste des Petits Ruminants) have been selected; they are both capable of causing plagues of great severity with Rinderpest being the greatest animal plague of all time. The monograph is multi-authored with 17 chapters which takes the reader through the overall morbillivirus family, the genome, the clinical and pathological disease, the immunology and also vaccine progression from the earliest times to the present molecular candidates; these offer the potential for 'marker' vaccine status.

Understandably, there is a fine review of the outstanding programme (Global Rinderpest Eradication Programme – GREP) that has brought the world to the very brink of global eradication of this great scourge of animal health and welfare. Interspersed with the science are fascinating chapters on the history of the plagues and their therapies throughout the centuries, particularly the 19th and 20th centuries; where, at times, 80 % of livestock died from the emerging pandemics. This makes the international cooperation of GREP (and the related earlier control programmes) all the more impressive; it is aimed to eradicate the disease worldwide by 2010! This is a good read and worthy of all virologists' attention.

***Joe Brownlie**, Royal Veterinary College, Hatfield*

Pathogenic *Treponema* Molecular and Cellular Biology

Edited by J.D. Radolf & S.A. Lukehart
Published by Caister Academic Press (2006)
£140.00/US$280.00 pp. 466
ISBN 1-90445-510-7

Written by leading experts in the field, this comprehensive review reveals the main breakthroughs of research on pathogenic *Treponema* that affect public health worldwide. Its scope is widened by comparison to bacteria of closely related families, such as Lyme disease or leptospiral agents: this unveils patterns common to other pathogenic and motile spirochetes. Their pathogenic mechanisms, consisting of the intricate innate and adaptive immune responses elicited by treponemes are precisely outlined. The comparative genomics data summarized in this book bring to light the structure and metabolism of the diverse treponemes from the human genital and oral cavities. Powerful molecular and genetic tools, well illustrated through the chapters, are encouraging for future discoveries even if it is pointed out that the cultivation of the aetiologic agent of syphilis is still impossible. A historical part, going back to the fifteenth century when sexual transmission of syphilis or 'French disease' was unknown, gives also a sociologic perspective. This compilation will serve as an essential reference for students and scientists in microbiology and immunology and will broaden the readership to those interested in very fastidious bacteria which are still challenging.

***Isabelle Saint Girons**, Institut Pasteur*

Reviews on the web

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

Pathogenesis of Human Pulmonary Tuberculosis: Insights from the Rabbit Model

Probiotic Dairy Products

Diagnostic Bacteriology Protocols 2nd edn

Manufacturing Yogurt and Fermented Milks

Microbiology and Technology of Fermented Foods

Gastrointestinal Microbiology

Handbook of Plant Virology

Bacterial Genomes and Infectious Diseases

Biological Safety Principles and Practices 4th edn

Alpha Herpesviruses Molecular and Cellular Biology

Gene Therapy for Neurological Disorders

Agrobacterium Protocols 2nd edn Volume 2

Emerging Infections 7

letters/opinions

The November issue of *Microbiology Today* on a Systematics theme was very well received. The articles also provoked some interesting debate. The following items have been selected for publication.

Classifying protists

The November 2006 issue included a commentary on our understanding of the diversity of 'Protozoa'. It was editorially heralded with the statement '*After decades of radical reform, protozoan systematics has reached a consensus*'. If consensus means that data provide congruent insights and/or that most researchers agree on what the insight is, then consensus has not arrived on either front.

The article mentions 54 suprafamilial taxa. We have assigned these to broad categories (Table 1). The qualifications for placing each taxon in a column are precluded because of space.

Over half of what is referred to as part of the 'settling down' of the consensus remains in debate. There is consensus, but it is with the taxa established by the end of the 20th century on the basis of anatomical studies (Patterson, 1999, The diversity of eukaryotes. *Am Nat* **154**, S96–S124). The lack of consensus at higher levels is remarkable given that the logic for using comparative sequence analyses to infer phylogenies seems unassailable. We have shown, through meta-analysis of a large number of molecular surveys, that the monophyly of emergent supergroups 'Amoebozoa', 'Chromalveolates', 'Excavates', 'Plantae' and 'Rhizaria' is contra-indicated by many comparative molecular studies (Parfrey & others, 2006, Evaluating support for the current classification of eukaryotic diversity. *PLoS* in press). The remaining supergroup, the opisthokonts, lacks a clear identity. In the sense of a group that brings together animals and true fungi, it is very frequently supported, but not sufficiently as to silence dissenters who regard plants as forming the sister group to the animals. The deep elements of the tree of eukaryotes are difficult to resolve for a diversity of reasons. The heterogeneous rates of evolution present problems to the algorithms that are designed to reconstruct phylogeny. This problem is compounded by lateral gene transfer, excessive paralogy, and, we believe, – most significantly – by taxonomic undersampling.

Uncertainty arises from other areas as well. There is an over-readiness to use hypothetical synapormorphies as bases for new taxonomies before adequate opportunity has been provided to test the hypotheses. The instability of many taxa, whether indicated by their short life as taxa or by the need to continually redefine the concepts (as with Loukozoa or the now lapsed Archezoa), is evidence of premature actions. As an example, the distinction between unikonts and bikonts is weak because the argument depends on features of flagellar (in the article referred to as ciliary – revealing a further absence of consensus) transformations, a process that has been studied in too few microbial eukaryotes for us to be confident of patterns. Instability also emerges from a lack of nomenclatural discipline. Many terms are not defined when they are used or familiar terms are 'hijacked' and used to badge different assemblages of organisms. As a result, Amoebozoa, Plants, Protozoa, Heliozoa, and Fungi all have more than one meaning and their use in dialogue about eukaryotic evolution remains confusing.

Table 1. Categorization of suprafamilial taxa reflecting degrees of 'consensus'

Widely accepted	In use but ambiguous	In use but consensus lacking	Widely rejected as monophyletic taxa
Alveolata	Apusozoa	Amoebozoa	Algae
Animals	Cercozoa	Bikonts	Amoebae*
Ants	Chrysomonads	Cabozoa	Heliozoa
Apicomplexa	Choanozoa	Corticates	Flagellates*
Choanoflagellates	Dinozoa	Chromalveolates	Fungi
Chlorarachnean algae	Glaucophyta	Chromista	Plantae
Ciliates	Heterokonta	Diphyllatea	Protozoa
Cryptista	Foraminifera	Discicristata	Sporozoa*
Dinoflagellates	Jakobea	Excavata	
Euglenoids	Malawimonadea	Loukozoa	
Euglenozoa	Opisthokonta	Metamonads	
Haptophyta	Percolozoa	Radiozoa	
Mastigamoebae	Rhizaria	Retaria	
Microsporidia	Thecamonadea	Unikonts	
Myxozoa			
Rhodophyta			
Suctoria			
Viridaeplantae			

*Taxa rejected in the *Microbiology Today* article.

The resolution of the early and main branches of the tree of eukaryotes is not yet in consensus. There is a continuing need for investment in the exploration and resolution of deep branches of the eukaryotic tree of life. Within the US, several major studies within the *NSF Assembling the Tree of Life* programme embrace the microbial eukaryotes. We remain optimistic that increasing taxon sampling combined with dispassionate evaluation of all available evidence will bring more robust understanding of the origin and diversification of eukaryotic life. But not for a few more years at least.

David J. Patterson, Debashish Bhattacharya, Jeff Cole, Micah Dunthorn, John Logsdon, Laura Katz & Laura Wegener Parfrey
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Tom Cavalier-Smith replies:

This letter mixes sense, over-simplification, tendentiousness, quibbles and misleading error. I entirely agree over the difficulty of resolving basal eukaryotic branches and the need for much more megaphylogenetic research and better taxon sampling, but disagree with numerous other judgements.

I do not use algae, bikonts, unikonts, opisthokonts, chromalveolates, cabozoa, corticates as taxa; nor do I reject Sporozoa. Fungi and Plantae in my sense since 1981 are actually widely accepted as mono/holophyletic taxa, not rejected. Heliozoa as I use it refers only to Centrohelea (holophyletic), plus perhaps a microheliozoan (needs more research). No taxon in column 2 is ambiguous as I define them, but some changed circumscription historically, which is only natural, and is also true of many in column 1, and partly why some taxa are in columns 3–4. Glaucophyta is totally unambiguous; Cercozoa is too, despite crazily erratic misuse by some.

Nobody claims that Protozoa is a holophyletic taxon, but it is a perfectly respectable paraphyletic one (see Cavalier-Smith, 1998, A revised six-kingdom system of life. *Biol Rev* 73, 203–266.).

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The species concept

It was good to read the interesting articles on systematics in the November issue of *Microbiology Today*. The admirable discussions on the species concept, however, suffer from a fundamental misconception that is seen in almost all contributions to this topic in microbiology in recent years. This is the advocacy of a single molecular measure to define species.

The term 'species' was taken from Latin by the early botanists and zoologists in the sense of the smallest distinct groups of individual organisms, that is, the members of a group were not only very similar to each other, but the group was also distinct from nearby groups.

The earliest usage did not prescribe in what manner groups were distinct, though it was usually based on some form of overall morphological similarity. The groups thus corresponded to primary clusters. These were the smallest clusters that were clearly distinct from others. The same can hold good today for groups from molecular sequence or other data. At this taxonomic level it is scarcely material whether the computer analyses are phenetic or phylogenetic.

The concept of primary distinct clusters has been retained by botanists and zoologists to this day, though sometimes qualified by additional criteria. Thus, in plants an extremely homogeneous group, whose members are scarcely distinguishable, is a 'microspecies'. In zoology two groups that do not interbreed but are otherwise scarcely distinguishable are 'sibling species'.

As was noted in these discussions, the concept of a 'biological species' as a group that does not interbreed with others cannot be used in bacteria. But the corollary, that now we can measure molecular relationship a species should be defined by some single chosen level of similarity, is unsound. This cannot accommodate both variable and homogeneous primary clusters. It is ironic that, having found an objective measure of relationship, it should be advocated in this manner for the taxonomic category to which it is least applicable.

Under the definition of a species as a primary cluster, only a single strain (the type strain) is needed to anchor it unambiguously in the system. One may have to work with more strains to find the similarities between them all, and so to obtain primary clusters, but it gives a sounder taxonomy. Taxonomy is an information system. Primary clusters are indispensible for this, both for information retrieval and nomenclature.

Peter Sneath
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Why every protist needs a barcode

Sorting out what we mean by a species, and bringing order to higher level groupings, are important activities for microbial taxonomists. But **Phil Williamson** and his colleagues argue that the real priorities are more prosaic, yet pragmatic: 'what exactly is out there?' and 'what features should we use to routinely distinguish organisms of different kinds?'

Modern systematics isn't stamp-collecting. Even for microbial taxa of relatively limited known diversity, no-one expects to encounter the complete set. Efficient identification systems are, however, essential to link biodiversity and ecosystem services, to help achieve effective disease control and to exploit biotechnological resources. All these applications require unambiguous and standardized naming frameworks, anchoring the name to a real specimen or culture. That standard framework is currently provided by the International Codes for Botanical and Zoological Nomenclature, and the International Committee on Systematics of Prokaryotes (ICBN, ICZN and ICSP). Unfortunately, there are serious mismatches between the operational requirements of these Codes and microbial reality. At the current rate of progress, it will take more than 600 years to properly describe the ~10 million 'known unknowns', and potentially an order of magnitude higher for 'unknown unknowns'.

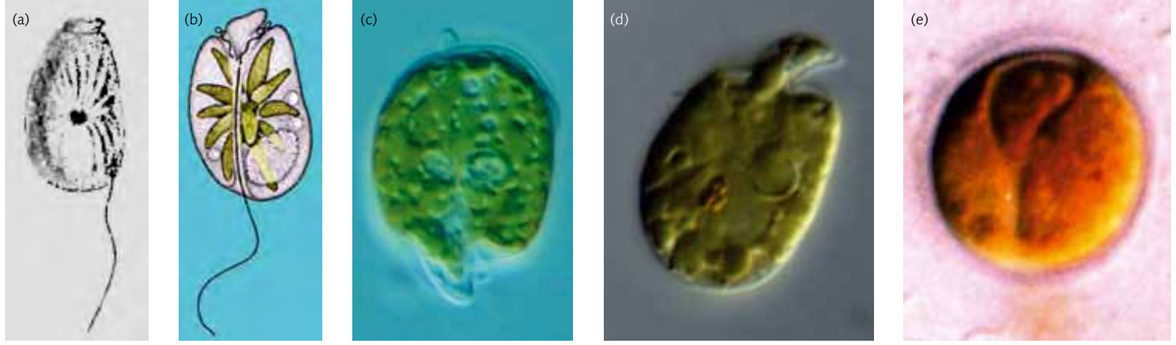
For prokaryotes (bacteria and archaea), diversity issues are particularly acute. In a single litre of seawater, there can be three times more prokaryotic operational taxonomic units than the global total of ~6,000 recognized species. The naming problem for such groups has, however, been somewhat sidestepped; first, by use of the 'candidatus' label for taxa that have yet to be cultured (and hence don't fully comply with the current ICSP Code); and second, by a range of de-replication procedures, including ribotyping (using 16S and 18S rRNA tag sequences) and whole-cell fingerprinting (e.g. based on mass spectrometry). Although ribotyping isn't generally known as barcoding – the shorthand term for the molecular sequencing identification framework for higher plants and animals (www.barcodinglife.org) – it is basically the same thing: characterization using a short and species-specific DNA sequence from a standard position in the genome.

Protist issues

For protists (used broadly, not implying monophyly), at least 200,000 species have been formally described, based on phenotypic features, and several thousand representative strains are maintained in culture. But the evolutionary history of protists is extremely complex, and while phylum-level identities are reasonably clear, relationships between taxa are far from straightforward. Other major problems include the near-impossibility of long-term culture of many parasitic, and highly host-specific, groups (yet these are arguably of greatest economic importance); a lack of congruence of ICBN and ICZN protocols in the protist realm (14 % of generic names for plants have also been used for non-plants); and a lack of consensus on suprafamilial systematics (despite claims to the contrary in the November 2006 issue of *Microbiology Today*). Furthermore, most original descriptions for protist species are based on light microscopy and ink drawings, not only making species identification for some groups an inherently subjective and specialist occupation, but also potentially hiding major genetic diversity.

The barcoding solution

To help resolve many of the contradictions and uncertainties in protist taxonomy, genetic barcoding is the way forward, starting with material, particularly type strains, in internationally recognized culture collections. Such an approach was unanimously agreed by 40 protist experts from 12 countries (Australia, Canada, Denmark, France, Germany, Japan, Malaysia, Netherlands, Norway, Russia, UK and USA) at a workshop last November in Portland, Maine, funded by the Sloan Foundation and co-organized by the Culture Center for Marine Phytoplankton (hosted by Bigelow Laboratory for Ocean Science) and the NERC Culture Collection of Algae and Protozoa (Scottish Association for Marine Science).



◀ Fig. 1. Images of dinoflagellates that have been identified as *Amphidinium operculatum*. But there are ~150 other described species in the genus; are all these the same species? Barcoding should help to resolve such uncertainties. (a) Illustration for the type description of *A. operculatum* Claparède & Lachmann 1859; (b) graphic image (http://microscope.mbl.edu); (c) light micrograph of CCMP strain 123 (http://microscope.mbl.edu); (d) light micrograph of CCAP strain 1102/06 (Edmund Nash); (e) non-motile cell (Mona Hoppenrath & Shauna Murray).

Barcoding is a benchmarking process. On their own, barcodes cannot confer new species status, nor evaluate phylogenetic relationships. Nevertheless, when used with an appropriate bioinformatics database, relatively short DNA sequences (a few hundred base pairs) offer rapid and effective identification with good species separation (unambiguous outcomes for >90 % of case studies to date). Costs are currently $3 per DNA extract, with the analysis process taking a couple of hours. The aim is to achieve at least an order of magnitude reduction in costs and time within a decade, so that bio-barcode analysers can be routinely used in every science laboratory and school, and taken on every field-collection trip.

For animals, the COI (cytochrome *c* oxidase I) locality is the preferred gene region, while the suitability of a chloroplast gene is currently being investigated for plants. For protists, the Canadian Barcode of Life Network will initially compare COI data for around 1,000 DNA extracts (for ~100 species, ~10 strains of each). If that target does not give good separation, other markers will be tested; alternatives anyway will be necessary for protists lacking mitochondria suitable for rRNA analyses.

Testing the system

Having several, independently collected isolates of what is considered to be the same species is clearly of great value to launch (and test) a protist barcoding initiative. For example, there are currently at least eight strains of the marine dinoflagellate considered to be *Amphidinium operculatum* (and many other strains of '*Amphidinium* sp.') in seven culture collections in five countries. This material has been collected from many locations, including the south-west Pacific, but none from the type locality (Norway). If all the *A. operculatum* strains match by barcoding, that will be reassuring. If they don't, some further work – with more detailed characterization – will be necessary, since it is not obvious which strain should retain the *A. operculatum* name and be declared the epitype, as the new standard for future reference. The original (1859) type illustration of *A. operculatum* is shown in Fig. 1, together with some other images of organisms currently considered to be that species.

International co-operation

A co-ordinated, international approach to protist barcoding led by culture collections, and assisted by other molecular and non-molecular approaches, will have other desirable outcomes. In particular, barcodes will provide a robust quality control of what is kept in culture, whilst avoiding unnecessary replication. This is important since collections provide the reference for species identity; they also serve as patent depositories (under the Budapest Treaty of 1977) and provide model organisms for physiological and biochemical studies. Mislabelling of cultures due to human error can occur, even in extremely well-managed collections. Without a routine genetic identity check, such mistakes are likely to be perpetuated.

In conclusion

Gene sequencing approaches to taxonomy are not without critics, who have expressed concern that principles are being sacrificed for the sake of expediency. But barcoding is intended to complement, not replace, traditional methods for understanding and classifying whole organisms. For protists, the emphasis is on facilitating identification, confirming in hours what otherwise might take many months of paper-based or culture-based cross-referencing. Such an advance will re-invigorate and potentially revolutionize the study of protists, whilst greatly enhancing the value of relevant culture collections.

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Further reading

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International Development Fund reports

The International Development Fund provides small grants to members to help microbiologists in developing countries and Eastern Europe. Closing date for 2007: 21 September. See the SGM website for details.

Chlamydia trachomatis and reproduction in Iran

Over the last few years *Chlamydia trachomatis* has emerged as the most common bacterial cause of sexually transmitted disease in the UK. Indeed rates of infection have increased dramatically during this time. It is therefore not surprising that a National *Chlamydia* Screening Programme is now in place in an attempt to reduce the number of infections and so help prevent important sequelae such as ectopic pregnancy and infertility.

Following an academic visit to the Avesina Research Institute (ARI), Tehran, in 2004, I was invited to take part in a WHO-funded study investigating the prevalence of *C. trachomatis* in females attending obstetrics and gynaecology clinics in Tehran. Surprisingly, we discovered a high prevalence which inspired us to collaborate on a similar study in men. These findings of our collaborative studies led me to propose running a *Chlamydia* workshop in Tehran to raise the profile and awareness of *Chlamydia* in the Islamic Republic of Iran.

It was therefore appropriate that the ARI, headed by Dr Akhondi and which is the most comprehensive clinic for treatment of infertility in Iran, hosted the workshop in May 2006. Eighteen scientists and physicians who were mostly based in Tehran and members of staff from the ARI attended the five-day event which was opened by Dr Zali, the Chancellor of Shahid Beheshti University, where the ARI is located.

We were pleased that this Workshop was included in the CME (Continuous Medical Education) credit programme offered by the Iranian Ministry of Health and Medical Education. All the participants and lecturers gained the relevant certification.

The aims of the Workshop were to provide a comprehensive lecture programme on the clinical importance of *C. trachomatis* and to provide an in-depth series of practicals and demonstrations on the diagnosis of *C. trachomatis* in a clinical laboratory.

I was fortunate in having excellent help from the ARI, especially Dr Chamani and Dr Aarabi, in co-ordinating the lecture programme and practicals, respectively. From the discussions following each lecture, there was no doubt that there was great interest from the participants, and in the last lecture which looked at the feasibility of a *Chlamydia* Screening Programme in Iran, this initiated great excitement, although we realized that much needed to be done before this could realistically be considered.

Despite having devised a demanding practical programme, it was reassuring to see that all the diagnostic tests worked and that *C. trachomatis* was cultured at the ARI for the first time – a notable success for which my technical colleague in Sheffield, Mr Geary deserves much of the credit.

One of the outcomes of the Workshop was the desire to hold more such activities in Iran so that knowledge and expertise could be shared. It was even suggested that an annual *Chlamydia* update meeting be held to report on local activities. Of course, this was all very satisfying to me and I wish them every success with these endeavours in the future. However, none of this would have been possible without the support of the SGM and it clearly illustrates the importance of their International Development Fund. There is no doubt in my opinion that there is much to be gained from further studies on the importance of *C. trachomatis* in the Middle East as a whole.

Adrian Eley
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I am grateful to Dr Kokab, my PhD student and native Farsi speaker, for his many efforts in helping to make this workshop a success.

Bioinformatics and post-genomics molecular biology training in Africa

The SGM Fund provided bursaries for young African microbiologists to attend an international course organized in Kampala, Uganda, by Professor Keith Gull and members of his lab from the Sir William Dunn School of Pathology, University of Oxford.

Keith and three Research Fellows, Bill Wickstead, Eva Gluenz and Catarina Gadelha taught a course on *Bioinformatics and post-genomic molecular cell biology of African trypanosomes and malaria*. The course involved lecturers from the USA and Belgium in addition to local Ugandan and Kenyan scientists. It included a mixture of lectures, seminars and computer exercises. 25 students from Uganda, Kenya, South Africa, Mali, Nigeria, Cameroons Malawi and Ethiopia attended the course which was heavily over-subscribed with over 250 applications for places. The course was very timely since the *Trypanosoma brucei*, *Leishmania major* and *T. cruzi* genome sequences have been published over the last few years. Genome information about these and other parasitic protozoa is having an important impact on drug and vaccine research, in addition to our knowledge of the basic biology of these parasites.

There is great interest in Africa in modern parasitology research and teaching. This course provided an insight into both techniques and applications of bioinformatics, but placed that information in the context of how it enables discovery biology in these neglected diseases.

Keith Gull
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◀ Opposite page. Adrian Eley addresses participants in the *Chlamydia* workshop held at the Avesina Research Institute in Tehran in May 2006. *Adrian Eley*

◀ This page. African microbiologists on the malaria bioinformatics course held in Kampala, Uganda, being tutored by Dr Eva Gluenz. *Keith Gull*

elections07

A number of members of Group Committees retire in September 2007 at the end of their terms of office. Nominations are now required to fill the vacancies arising. Where the number of nominations to a Group Committee exceeds the number of vacancies, there will be an election by postal ballot. The current members of each Group Committee and number of vacancies are listed below. In making nominations, members are particularly asked to bear in mind the desirability of a breadth of scientific interest on each committee. Nominations, including up to five words describing the general area of interest of the nominee, should be sent to reach the appropriate Group Convener no later than **16 April 2007** (contact details on p. 41).

(C) Convener
(CE) Convener Elect
(CR) Council Representative
(CIR) Co-opted Industry Representative
* Retiring 2007

Cells and Cell Surfaces 3 vacancies

I.R. Henderson (C) *University of Birmingham*
Protein secretion, type V secretion, autotransporters, pathogenicity

A. Cunningham *University of Birmingham*
Salmonella, mycobacteria, innate immunity, surface antigens

S. Cutting* *Royal Holloway, London*
Sporulation, development, vaccines, cell signalling, proteolysis

J.R. Fitzgerald *University of Edinburgh*
Bacterial pathogenesis, genomics, evolution, surface proteins

R. Massey *University of Oxford*
Staphylococcus aureus, attachment and invasion, evasion

T. Palmer* *John Innes Centre, Norwich*
Protein transport, Tat pathway, membrane proteins

G.M. Preston* *University of Oxford*
Pseudomonas, plant–microbe interactions, protein secretion

S.G. Smith *Trinity College Dublin*
Pathogenicity, adhesion and invasion, genomics, proteomics

P.C.F. Oyston (CR) *Dstl Porton Down*

Clinical Microbiology 3 vacancies

D. Ala'Aldeen (C) *University of Nottingham*
Bacterial infections: pathogenesis and immunity

M.R. Barer* *University of Leicester*
Mycobacteria, viability, unculturables, microscopy, image analysis

S. Collier (CIR) *University College Hospital, London*
Training and education

S. Lang *Glasgow Caledonian University*
Staphylococci, Streptococci, virulence

D. Mack *University of Wales Swansea*
Staphylococcus, biofilms, antibiotic resistance, diagnostics

T.D. McHugh* *Royal Free & University College, London*
Tuberculosis, molecular epidemiology, molecular diagnostics

S. Patrick *Queen's University Belfast*
Anaerobes, opportunistic infection, normal microbiota

D. Ready *Eastman Dental Hospital, London*
Oral microbiology, control, antibiotic resistance, biofilms

M. Tunney* *Queen's University Belfast*
Biofilms, antibiotic resistance, anaerobic infection

I.R. Poxton (CR) *University of Edinburgh*

Clinical Virology 1 vacancy

J. Breuer (C) *St Bartholomew's Hospital, London*
Diagnostics, epithelia infections, HIV2, CNS infections

P. Cane *Health Protection Agency, Porton Down*
Viral evolution, RSV, HIV, drug resistance

A.R. Fooks *Veterinary Laboratories Agency, Weybridge*
Zoonoses, emerging and exotic viruses, RNA viruses

W.L. Irving *University of Nottingham*
Viral hepatitis, herpesviruses

E. MacMahon *St Thomas' Hospital, London*
Pathogenesis, clinical correlates, transplantation, HHV

E. O'Kelly *National Virus Reference Laboratory, Dublin*
Tissue culture, diagnostics, emerging infections, respiratory viruses

D. Pillay *University College London*
HIV, antivirals, drug resistance, molecular epidemiology

S.J. Skidmore* *Princes Royal Hospital, Telford*
Hepatitis C and E

G.L. Smith (CR) *Imperial College London*

Education and Training 1 vacancy

J. Verran (C) *Manchester Metropolitan University*
Applied microbiology, biofilms, group work

R.P. Allaker *Queen Mary's University of London*
Oral microbiology, dental student education

W. Ashraf *University of Bradford*
e-learning, CPD, widening participation, podcasting

S. Burton *University of Exeter*
Environmental microbiology, under- and postgraduate programmes

R. Dixon *University of Lincoln*
Ancient DNA, antibiotics, membranes, e-learning

R.M. Hall (CIR) *GlaxoSmithKline, Harlow*
Recombinant proteins, *E. coli*, fermentation, pharmaceuticals

L.M. Lawrance* *University of the West of England*
Medical/molecular microbiology, postgraduate/generic skills

M.J. Tully *De Montfort University of Leicester*
Pharmaceutical and cosmetic microbiology, basic skills

B.A. Unsworth *Leeds Metropolitan University*
Applied microbiology, lab classes, SCL

S.J. Assinder (CR) *University of Wales, Bangor*

Environmental Microbiology 2 vacancies

G.M. Gadd (C) *University of Dundee*
Geomicrobiology, metal–microbe interactions, sulfate reduction, fungi

D.W. Hopkins *University of Stirling*
C/N cycling, decomposition, extreme environments

R. Howarth (CIR) *WSP Environmental, Leeds*
Bioremediation, microbial ecology

J.W. McGrath *Queen's University Belfast*
Environmental microbiology, pollution, biodegradation

A.M. Osborn *University of Sheffield*
Biogeochemistry, molecular ecology, pollution

G.I. Paton* *University of Aberdeen*
Toxicity testing, microbial biosensors, bioremediation, soil ecology

R. Pickup *Centre for Ecology and Hydrology, Lancaster*
Natural attenuation processes, bacterial pathogens, catchments

K.T. Semple* *University of Lancaster*
Biodegradation, pollutants, ecotoxicology, bioremediation

C. Whitby *University of Essex*
Bioremediation of hydrocarbons and herbicides, C/N cycling

N.H. Mann (CR) *University of Warwick*

Eukaryotic Microbiology 2 vacancies

A. Goldman (C) *University of Sheffield*
Saccharomyces cerevisiae, meiosis, recombination

S. Crosthwaite *University of Manchester*
Neurospora, molecular basis of circadian rhythmicity

A. Harwood *University of Wales, Cardiff*
Dictyostelium discoideum, cell signalling and development

P. McKean* *University of Lancaster*
Trypanosomes, cytoskeleton

E.J.C. Mellor *University of Oxford*
Chromatin structure and transcription

N.D. Read* *University of Edinburgh*
Cell biology of filamentous fungi

O.A.E. Sparagano *University of Newcastle*
Tick-borne pathogens, zoonoses, diagnostics

S.K. Whitehall *University of Newcastle*
S. pombe HIRA nucleosome assembly, Zn-responsive gene expression

N.A.R. Gow (CR) *University of Aberdeen*

Fermentation and Bioprocessing 3 vacancies

C. Hewitt (C) *University of Loughborough*
Process monitoring, flow cytometry, *Escherichia coli*

P. Bentley *Pierre Guerin Technologies, Tewkesbury*
Sales, industrial/lab supplier, scale-up

D. Charalampopoulos *University of Reading*
Protein expression, cell response, modelling, bioprocess, renewables

R. Dennett* *Eden Biopharm, Ellesmere Port*
Recombinant proteins, business development

M. Ganzlin *AstraZeneca, Macclesfield*
Protein characterization, laboratory scale, process development

D.J. Glover (CIR) *UCB Celltech, Slough*
Fermentation, cell culture, scale-up

P.A. Hoskisson* *University of Aberdeen*
Chemostats, development, gene expression, actinomycetes

B. McNeil* *University of Strathclyde*
Fermentation, physiology of cultured cells, bioreactors

S. Stocks *Novozymes A/S, Bagsvaerd, Denmark*
Industrial fermentation, scale-up, enzymes, process development

K.A. Smart (CR) *University of Nottingham*

Food and Beverages 4 vacancies

R.A. Rastall (C)* *University of Reading*
Functional food ingredients, probiotics

M.A. Collins* *Queen's University Belfast*
Lactic acid bacteria, food fermentations

K. Grant* *HPA Colindale*
Food-borne pathogens, molecular detection, epidemiology

K. Jones *University of Lancaster*
Pathogens in agriculture and water

W. Morrisey *Green Isle Foods, Naas, Ireland*
Food spoilage yeasts and bacteria

M.W. Peck *Institute of Food Research, Norwich*
Food safety, *Clostridium botulinum*, physiology

C. Rees (CE) *University of Nottingham*
Listeria, low temperature adaptation, bacteriophage

J.F. Rigarlsford (CIR) *Tansley, Derbyshire*
Consultant, food hygiene

C.R. Harwood (CR) *University of Newcastle*

Irish Branch 3 vacancies

E.M. Doyle (C) *University College Dublin*
Biodegradation, bioremediation

C.C. Adley *University of Limerick*
Food-borne pathogens, biofilms, *Ralstonia pickettii*

J. McGrath *Queen's University Belfast*
Phosphorus metabolism, wastewater treatment, biodegradation

J.R. Marchesi* *University College Cork*
Unculturables, ecology, gut ecosystems, biodegradation

A. Moran* *National University of Ireland Galway*
Glycobiology, physiology, pathogenesis, biofilms, microaerophilics

J. Morrissey *University College Cork*
Fungal pathogenesis, bacterial–fungal interactions, microbial ecology

C.D. Murphy* *University College Dublin*
Secondary metabolites, biosynthesis, dehalogenation

C. O'Byrne *National University of Ireland, Galway*
Molecular response to stress in bacteria

C.J. Dorman (CR) *Trinity College Dublin*

Microbial Infection 3 vacancies

N. Dorrell (C) *London School of Hygiene and Tropical Medicine*
Pathogenicity, *Helicobacter*, *Campylobacter*, microarrays

H. Allison *University of Liverpool*
Bacteriophages, virulence, toxins, food-borne disease

P.H. Everest *University of Glasgow*
Campylobacter, *Salmonella*, cellular microbiology, host response

B. Kenny *University of Newcastle*
Host–bacterial interaction, *Escherchia coli*, type III secretion

P.R. Langford *Imperial College London*
Bacterial pathogenicity, veterinary diagnostics, proteomics

K. Robinson* *University of Nottingham*
Neisseria, *Helicobacter*, immunity, vaccines

K. Stevenson* *Moredun Research Institute, Midlothian*
Molecular pathogenesis, mycobacteria, proteomics

N. Waterfield* *University of Bath*
Genomics, toxins, pathogen evolution, invertebrates, innate immunity

M.R. Barer (CR) *University of Leicester*

Physiology, Biochemistry and Molecular Genetics 4 vacancies

G.P.C. Salmond (C)* *University of Cambridge*
Quorum sensing, virulence, antibiotics, phages

G.W. Blakely *University of Edinburgh*
Recombination, pathogenesis, comparative genomics

D. Clarke* *University of Bath*
Signal transduction, symbiosis, pathogenicity, biofilms

J.A. Downie *John Innes Centre, Norwich*
Rhizobium, quorum sensing, legume nodulation, secreted proteins

D.H. Edwards *University of Dundee*
Cell division, chromosome segregation, sporulation, antibiotics

D. Lamb* *University of Wales, Swansea*
Functional genomics, molecular genetics, *Streptomyces*

P. Lund* *University of Birmingham*
Chaperones, stress responses, protein folding

F. Sargent *University of East Anglia*
Respiration, membranes, biosynthesis

R.M. Hall (CR) *GlaxoSmithKline, Harlow*

Systematics and Evolution 2 vacancies

N.A. Logan (C) *Glasgow Caledonian University*
Classification and identification of *Bacillus*

S.P. Cummings* *University of Sunderland*
N-fixing, psychrophylic and cyanide-degrading bacteria

R. Goodacre *University of Manchester*
Whole organism profiling, spectroscopy, chemometrics

L. Hall *Barts and the London School of Medicine*
Antibiotic resistance, evolution, mutation, mobile elements

P.A. Lawson* *University of Oklahoma, USA*
Molecular systematics, phylogeny, taxonomy, 16S rRNA

M. Upton *Manchester Royal Infirmary*
Molecular epidemiology, phylogeny of bacterial pathogens

A. Willems *University of Gent, Belgium*
Taxonomy, diversity, phylogeny, *Proteobacteria*, rhizobia

J.P.W. Young *University of York*
Bacterial genetic diversity, genome evolution

C. O'Reilly (CR) *Waterford Institute of Technology*

Virus 5 vacancies

R.E. Randall (C)* *University of St Andrews*
Paramyxoviruses, interferon/immunity and vaccines

S. Brookes* *Veterinary Laboratories Agency, Weybridge*
Virus morphogenesis, pathogenesis, zoonotic viruses, lissaviruses

M. Cranage *St George's, University of London*
HIV, retroviruses, virus vaccines

S.V. Graham *University of Glasgow*
Papillomaviruses and cancer

N. Mabbott* *Institute of Animal Health, Edinburgh*
Prions

B.A.B. Martin *University of Birmingham*
New virus agents, antivirals

L. Roberts *University of Surrey*
Translation mechanisms. caliciviruses, picornaviruses

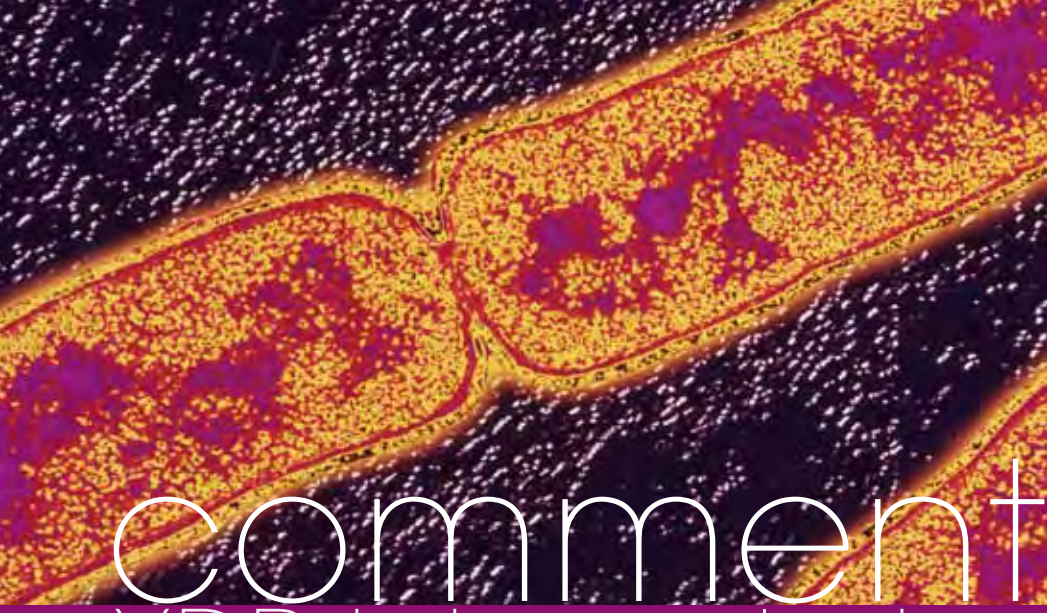
S.G. Siddell* *University of Bristol*
Coronaviruses, positive-strand viruses

A.J. Sinclair *University of Sussex*
Gamma herpesviruses, oncogenic viruses, transcription, cell cycle

J.A. Walsh *Warwick HRI*
Plant viruses

G.W.G. Wilkinson* *University of Wales College Medicine, Cardiff*
Cytomegalovirus, adenovirus vectors, immune evasion

B.K. Rima (CR) *Queen's University Belfast*



comment

XDR tuberculosis – untreatable disease or the X factor in mycobacteriology?

XDR TB is a serious and emerging public health threat. But what is XDR TB and how can it be controlled? **Ibrahim Abubakar** takes a look at recent developments.

It appears that not only TV producers use the letter X to attract public attention. International tuberculosis (TB) experts are also following this trend. The identification of strains of *Mycobacterium tuberculosis* resistant to isoniazid, rifampicin and at least three additional classes of second-line drugs (aminoglycosides, polypeptides, fluoroquinolones, thioamides, cycloserine and *p*-aminosalicyclic acid) raises the spectre of a post-antibiotic era for TB. The authors of the first published report on this phenomenon used the term extensively or extreme drug-resistant TB and coined the interesting acronym XDR.

If the infecting organism is susceptible to three or fewer classes of second-line anti-TB drugs, treatment is unlikely to meet international standards. However, this definition does not consider important differences in the roles of the drugs in the treatment of TB.

XDR TB gained considerable media attention in August 2006 following the presentation of data at the World AIDS Conference in Toronto on an outbreak with very high mortality and HIV co-infection rate in South Africa. Recently, more details of this outbreak have been published, confirming the high mortality and presenting evidence of nosocomial transmission. Although cases of XDR TB have been reported from most parts of the world, the true extent of XDR remains unclear at moment; the original report showed that 19, 4.1 and 15 % of multi-drug resistant (MDR) cases in Latvia, USA and South Korea, respectively, met the definition of XDR TB.

Results from various countries are difficult to compare due to the lack of international standards and the limited reproducibility of drug susceptibility testing for second-line drugs. In view of this and the shortcomings of the initial definition, a WHO working group has revised the laboratory definition of XDR TB. It is now agreed that XDR TB refers to MDR TB (disease caused by organisms resistant to isoniazid and rifampicin) that is also resistant to a fluoroquinolone and at least one of three injectable second-line anti-TB drugs (capreomycin, kanamycin and amikacin).

In the UK, first-line drugs susceptibility testing is available at the Mycobacterium Reference Unit (MRU) and at Mycobacteriology Centres. A national drug susceptibility testing service for second-/third-line drugs is provided by the Health Protection Agency's MRU. The MRU is a WHO SupraNational Reference Laboratory and European Co-ordinating Centre within the Global Programme on Drug Resistance and operates an EQA for drug resistance on behalf of the WHO. A very small proportion of UK MDR TB cases would now be classed as XDR TB under the new criteria. There is no suggestion that XDR TB cases are increasing in the UK.

The WHO has outlined the steps required to control further spread of these strains. The recommended measures include improved case detection for MDR TB, accelerating access to rifampicin resistance testing, effective treatment of MDR in all patients, implementation of infection control measures and strengthening surveillance.

XDR TB is a serious and emerging public health threat. The problem has arisen because of failures in the public health infrastructure and in delivering an effective case management system. Urgent public health action is necessary in settings with high drug resistance, and continued vigilance and preventive measures are required globally if we are to combat this threat.

▲ False-coloured transmission electron micrograph of *Mycobacterium tuberculosis*. *Alfred Pasieka / Science Photo Library*

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Further reading

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Gandhi, N. & others (2006). *The Lancet*, 368, 1575–1580.

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