MICROBIOLOGY TODAY

QUARTERLY MAGAZINE OF THE SOCIETY FOR GENERAL MICROBIOLOGY VOLUME 27 FEBRUARY 2000

Contents

SGM Headquarters
Marlborough House,
Basingstoke Road, Spencers
Wood, Reading RG7 1AE
Tel. 0118 988 1800
Fax 0118 988 5656
e-mail mtoday@sgm.ac.uk

SGM Website
http://www.sgm.ac.uk

Editor
Dr Dave McL. Roberts

Editorial Board
Dr Ulrich Desselberger
Professor Dave Kelly
Professor Dave Rowlands

Managing Editor
Janet Hurst

Production Editor
Ian Atherton

Assistant Editor and Book Review Manager
Janice Meekings

Contributions
These are always welcome and should be addressed to the Editor (c/o SGM Headquarters).

Copy Dates
Last dates for receipt of copy at Marlborough House are:
General Copy
May issue 6 March
August issue 15 May
Advertisements (CRC)
May issue 17 April
August issue 12 June

Advertisements
All enquiries should be sent to:
Sarah McClune, NWH Sales Ltd,
The Arcade Chambers,
The Arcade, Aldershot,
Hampshire, GU11 1EE
Tel. 01252 357000
Fax 01252 357001
e-mail sarah@nwh.co.uk

Special Mailings
All enquiries should be sent to:
Janice Meekings (SGM HQ)
Tel. 0118 988 1802
Fax 0118 988 5656
e-mail j.meekings@sgm.ac.uk

Subscriptions 2000
NON-MEMBERS
Microbiology Today £45.00 (US$80.00)
MEMBERS
All members receive *Microbiology Today*. In addition they may take any of the Society's journals.
Ordinary Member
Membership Subscription (inc. *Microbiology Today*) £39.00 (US$68.00)
Microbiology £65.00 (US$125.00)
JGV £65.00 (US$125.00)
IJSEM £65.00 (US$125.00)
Student or Retired Member
Membership Subscription (inc. *Microbiology Today*) £20.00 (US$33.00)
Microbiology £32.00 (US$60.00)
JGV £32.00 (US$60.00)
IJSEM £65.00 (US$125.00)
Undergraduate Member
Membership Subscription (inc. *Microbiology Today*) £10.00

The views expressed by contributors are not necessarily those of the Society; nor can the claims of advertisers be guaranteed.

© 2000 The Society for General Microbiology; ISSN: 1464-0570

Design: Graphics International

Above: What does the future hold as microbiology moves ino the new millennium? *Photo courtesy The Image Bank.*

Vol. 27, Part 1, February 2000

In this issue we consider some of the ways forward in microbiology, both to combat the effects of harmful microbes and to harness their activities to solve problems. Such work requires money and on p. 2 SGM President Howard Dalton explains how effective communication of our science to the public and policy makers is crucial if future research is to be funded properly.

A major challenge for microbiologists is to develop new strategies against microbial infections. A whole symposium will be devoted to this at the Society meeting at Warwick, as previewed by Petra Oyston on p. 7. The widespread emergence of antimicrobial resistance presents a particular challenge and Ian Chopra describes how the antibiotics of the future will be developed. Tom Humphries and colleagues (pp. 10–12) look at the factors responsible for the marked increase in food-borne disease of recent years and consider the implications of current research in the field.

One way of detecting infection is by smelling the patient! Modern technology is enabling this art to be turned into a science, as Tim Gibson *et al.* show (pp. 14–16).

Beneficial microbes are widely used to clean up environmental pollution. Ajay Sharman and Cliff Burton describe the development of a novel bioremediation system to treat waste solvent in the footwear industry (pp. 18–20).

In Europe a consortium of research groups is investigating mobile genetic elements in bacteria, with a view to exploiting their potential in industry, agriculture, medicine and environmental management, as Chris Thomas and Konny Smalla describe on pp. 24–28.

However, microbiologists should exercise caution before embarking on a new project. As Milton Wainwright notes (pp. 8–9), it may all have been done before! And Howard Gest postulates that bacterial taxonomists may well be barking up the wrong phylogenetic tree (pp. 28–30).

Other topics covered include benchmarking, educational resources and the future of learned societies.

Articles

Regular Features

Other Items

Microbiology into the new millennium

Howard Dalton

I was in the pub last Sunday lunchtime after my usual doubles tennis match when one of my opponents, Bernard, asked me when we scientists were going to sort ourselves out. He was referring to an article he had read in the paper that morning about how the BSE epidemic was now reported to be caused by the common soil bacterium *Acinetobacter calcoaceticus*. The article reported that prions were the breakdown products of damaged nervous tissue caused by the antibodies produced against the invading bacterium mistaking brain cells for bacteria due to similar shared protein sequences (my words, not his). Now I am not going to pass judgement one way or another on either hypothesis to explain the causes of BSE, it is far too early to do that, and that was the essence of my argument with Bernard. On reflection it occurred to me that I was rather curt and dismissive. This was largely because I wasn't in charge of all the facts since I hadn't read the article in the newspaper or its source in *Infection and Immunity* (but when has that stopped such a discussion?), but it made me think a little about microbiologists and their rôle in interacting with the public.

COURTESY TRAVEL INK/ RONALD BADKIN

As scientists, mostly funded from the public purse, we have a responsibility to present information in a balanced and largely non-judgemental way so that the public and elected government ministers are in a position to make important decisions that can affect our lives. As microbiologists we are very much in the limelight these days as we reach a new era when microbes appear to be developing more sophisticated mechanisms to evade antibiotic attack and host defence mechanisms. The public has a right to be concerned about the safety of food and we, as microbiologists, must maintain the pressure on government and the regulatory authorities to ensure that there is a correct and measured response that can allay fears rather than engender them. In this first issue of *Microbiology Today* for the new millennium, important issues that include food safety and resistance mechanisms in bacteria and viruses are discussed and serve to inform us so that we may pass such information on to others. Thus, your quarterly magazine acts as a valuable sourcebook of informed argument that can and should be used whenever you need to engage the public. A major step forward for the Society this year is the joint meeting with the Society for Applied Microbiology to be held at Warwick in April. The theme, fighting infection, is an important one and worthy of debate. It is certainly the sort of topic that will grab the attention of all of us and I know it will be a great success. As a Society, however, we must not be selfish but must share this information responsibly and not be seduced into giving sound bites because it is expedient to do so.

My colleague Allan Hamilton wrote in the last issue of *Microbiology Today* about irresponsible and sensation-seeking journalism that often erodes the veracity and reputation of microbiologists. It is essential that we gain the confidence of the public and try to avoid complex jargon and neologisms that more often than not cause confusion and disdain. We must try to embrace the opportunities to present our work in a clear and positive way. After all there is a lot more to microbiology than the study of infectious 'nasties' – an unfortunate perception of our trade that has been given to us by the public. My own public performance via a television programme called *Mother Nature's Little Helpers* had its own rewards when a Leamington curry house refused to accept payment for a meal I had with my family because he enjoyed my TV performance so much. '*When was it on?*', I asked. '*Three in the morning*', he said, '*I couldn't sleep*'. So there went my 15 minutes of fame!

As I reflect upon the activities of the Society over the past years there is little doubt in my mind that its rôle in advancing the 'science and art of microbiology' has been more than adequately met. One only has to peruse any issue of *Microbiology Today* to see the vast range of activities and promotions that the Society has brought about. All of this has been due to indefatigable efforts of staff at Marlborough House, the Officers and Council Members of the Society, as well as the members of the groups that help meetings go so successfully. The Council is continually developing new projects to help stimulate public awareness of the subject and I believe that if we are to gain the trust, and with it the respect, of the wider community then we owe it to them to proselytise in a responsible manner. If we want more money to go into the subject then we must inform. The vast sums of money spent by various governments on expensive research programmes involving accelerators to split elementary particles into their component bits was made possible by the efforts of the nuclear physicists hinting to the media and government at the benefits to mankind that must surely follow once we know how to do it.

I'm off now to photocopy the article in *Infection and Immunity* so that I can show it to Bernard next Sunday and continue our debate; he is a taxpayer after all.

● *Howard Dalton, SGM President*

New drugs for the superbugs

Ian Chopra

As we enter the new millennium many of our existing antibacterial agents are under threat from the widespread emergence of bacterial resistance. Ian Chopra describes how the antibiotics of the future will be developed.

Undoubtedly, the golden period for antibiotic discovery took place between the 1940s and mid-1960s when many important antibiotic classes were first identified (Fig. 1). The subsequent development and clinical use of these antibiotics, or agents derived from them, produced impressive reductions in the morbidity and mortality imposed by bacterial pathogens. Indeed, the dramatic successes achieved in this period led to the commonly expressed view that antibiotic-based chemotherapy heralded the complete conquest of infectious diseases. Reflecting this optimistic mood, the US Surgeon General, testifying to Congress in 1969, made the historic statement, *'The time has come to close the book on infectious disease'*.

Unfortunately, this mood of optimism has not prevailed and the widespread emergence of acquired resistance to antibiotics in bacteria over the last 25 years now constitutes a serious threat to global public health.

The rise of the superbugs

The development of antibiotic resistance is a classic example of Darwinian evolution and is a direct result of competitive advantage conferred to the owners. Antibiotic resistance can result from mutation of existing genes but the problem is exacerbated by the ability of bacteria to acquire resistance determinants *en bloc* by genetic exchange. It is further compounded by demographic factors (e.g. population growth and urbanization), which generate fertile conditions for the transmission of infections, and new opportunities for inter-species traffic of pathogens to man.

The biochemical basis of bacterial resistance to most classes of antibiotics is now known and these mechanisms, either singly or in concert, are responsible for the escalating problem of antibiotic resistance, in both hospital-acquired (nosocomial) and community-acquired bacterial infections, that has already made many antibiotics virtually obsolete. Resistance to some antibiotics first became problematic in certain pathogens during the 1940s and has continued to the present day with the recent emergence of vancomycin-intermediate-sensitive *Staphylococcus aureus* (so-called 'VISA' strains) first reported in Japan (Fig. 2).

BELOW:
Fig. 1. The discovery of antibacterial agents. Empiric screening has been based upon the identification of antibacterial agents by their ability to inhibit bacterial growth. Synthetic approaches comprise chemical modification of existing drug classes to improve their properties, e.g. circumvention of resistance mechanisms to earlier members of the class. Only representative antibacterial agents are indicated. With the exception of the oxazolidinones, no novel, structurally unique, antibiotic class has been developed for over 20 years.

REPRODUCED FROM *CULTURE* 20, 3–6 (1999) BY PERMISSION OF EUROMED COMMUNICATIONS LTD

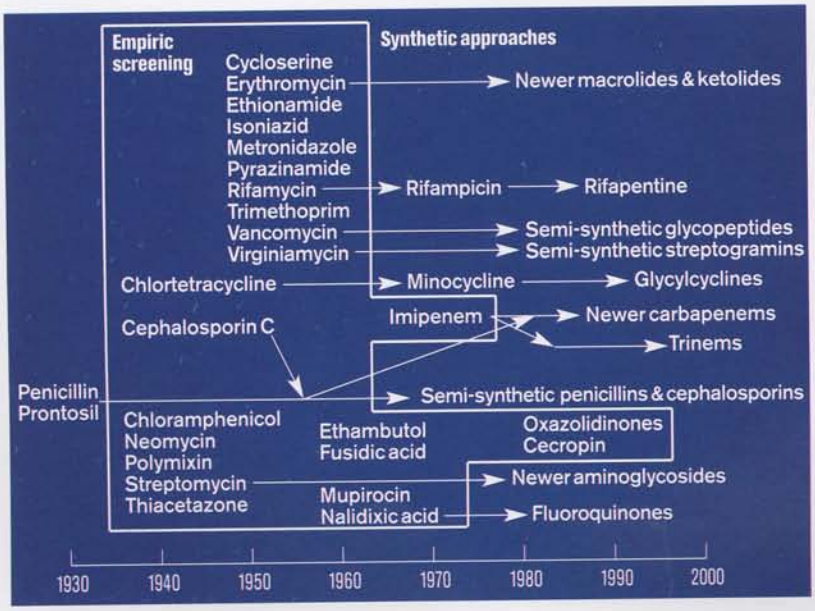


Table 1. The resistance crisis

■ The bottom line is that we are not facing an organism that has simply one resistance – that was a surprise in itself. But now we are facing major organisms that are multi-drug-resistant. That is, you can't use the first antibiotic of choice, you can't use the second, you can't use the third and sometimes you have to go to the fifth or sixth.
Levy, 1993, Tufts University Medical School, Boston, USA

■ We have now reached an unacceptable situation. Some hospital strains of invasive Gram-negative enteric bacteria and enterococci are not susceptible to any available drug.
Kunin, 1993, Ohio State University, Columbus, Ohio, USA

■ For the first time in five decades we now have a bacterial infection (caused by enterococci) for which there is no cure.
Tomasz, 1994, Rockefeller University, New York, USA

■ A resurgence of tuberculosis is cause enough for concern, but the new outbreaks have a frightening difference from earlier outbreaks of the disease. Many of the bacteria now causing new cases of tuberculosis are resistant to one or more of the drugs used to treat tuberculosis. Because the fatality rate of untreated tuberculosis is 50%, the possibility that untreatable strains could soon arise has set off a panic among public health workers.
Salyers & Whitt, 1994, University of Illinois, USA

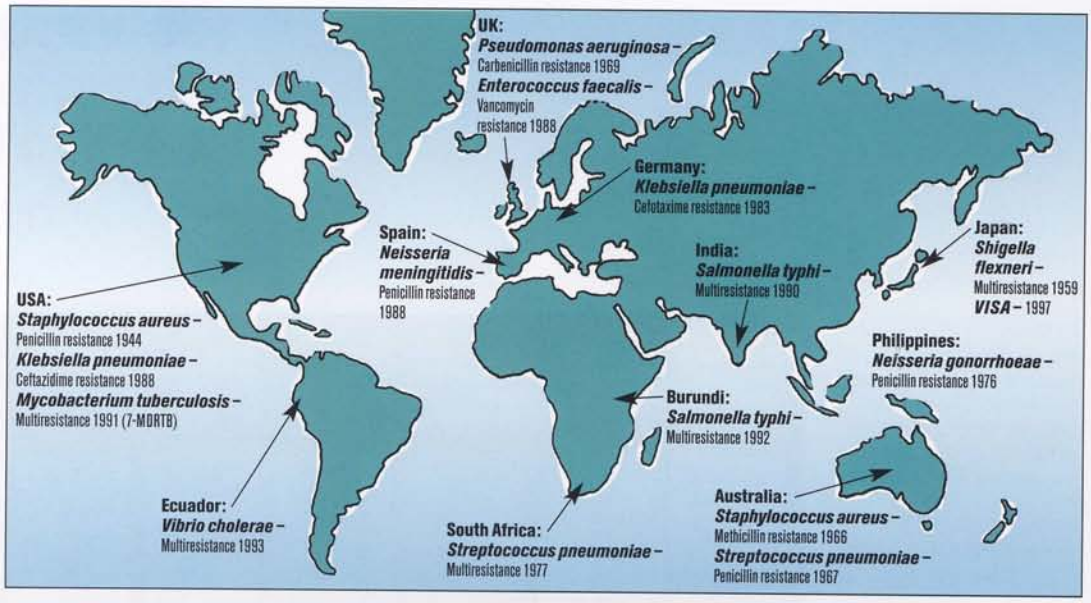
■ It is generally agreed that the acquisition of resistance to the last few available agents by highly virulent strains of staphylococci and pneumococci would be nothing short of a medical disaster.
Armstrong, 1995, Memorial Sloan–Kettering Cancer Center, New York, USA

■ The danger of a return to a pre-antibiotic era is now becoming a serious threat, particularly considering that no novel chemical class of antibiotics has been introduced in the past 20 years.
Bacquero, 1997, Ramon y Cajal Hospital, National Institute of Health, Madrid, Spain

■ The relative utility of available antibiotics is eroding, tipping the balance in favour of multidrug-resistant pathogens, and few new drugs appear to be on the horizon.
Cassell, 1997, University of Alabama, Birmingham, Alabama, USA

■ Our enquiry has been an alarming experience. Misuse and overuse of antibiotics are now threatening to undo all their earlier promises and success in curing disease. But the greatest threat is complacency, from ministers, the medical professions, the veterinary service, the farming community and the public at large. Our report is a blueprint for action. It must start now if we are not to return to the bad old days of incurable diseases before antibiotics were available.
Press release by Lord Soulsby, 1998, Chairman of the House of Lords Select Committee on Science and Technology dealing with resistance to antibiotics

■ The pharmaceutical houses continued to screen new natural products (i.e. microbial extracts) for antimicrobial activity, but compounds suitable for development ceased to be found. Now, in the closing years of the century, there is an uneasy sense that micro-organisms are 'getting ahead' and that therapeutic options are narrowing.
Department of Health Standing Medical Advisory Committee Report, 1998



ABOVE:
Fig. 2. The global emergence of antibiotic-resistant pathogenic bacteria. Examples are shown of the first major reports of clinical isolates expressing resistance to individual antibiotics, or groups of antibiotics. 7-MDRTB, strains of *M. tuberculosis* multiply resistant to seven of the eight preferred anti-tuberculosis agents; VISA, vancomycin-intermediate-susceptible *S. aureus*.

The serious nature of the current situation is reflected by quotations from leading infectious disease specialists and opinion leaders (Table 1).

Classical pharmaceutical approaches to the problem of antibiotic resistance will be insufficient to provide new agents in this century.

One approach to the problem of antibiotic resistance, adopted by the pharmaceutical industry, has involved the development of agents that circumvent existing resistance mechanisms or attack them directly. Typically, these so-called classical approaches have involved the following:

- Development of analogues of existing antibiotics that are either stable to enzymatic inactivation, not recognized by efflux pumps, or bind to the modified target sites in the organisms responsible for resistance, *or*
- The design of enzyme inhibitors to prevent microbial degradation of antibiotics.

The classical approaches described above have contributed important agents (Fig. 1) for use against resistant organisms. However, the improvements achieved have tended to be incremental and sometimes relatively short-lived, as new bacterial variants evolve with modified mechanisms of resistance, encompassing the newer analogues or enzyme inhibitors. For these reasons it is vital that research strategies to discover and develop the antimicrobial agents urgently required in the future move away from the classical approaches and towards the major opportunities now provided by bacterial genomics.

Genome-based approaches for the discovery of pioneer drugs

The combination of microbial resistance and lack of sustained progress in the discovery of structurally novel antibiotics demands a serious reassessment of future research and development approaches to antibiotic discovery. The only realistic solution is to embark on new research avenues to identify novel, or unexploited, bacterial gene products that can serve as targets for antibiotics and kill bacteria by completely different mechanisms from existing drugs. This decreases the likelihood of resistance problems because the possibility is high that structural novelty will circumvent any existing mechanism of resistance.

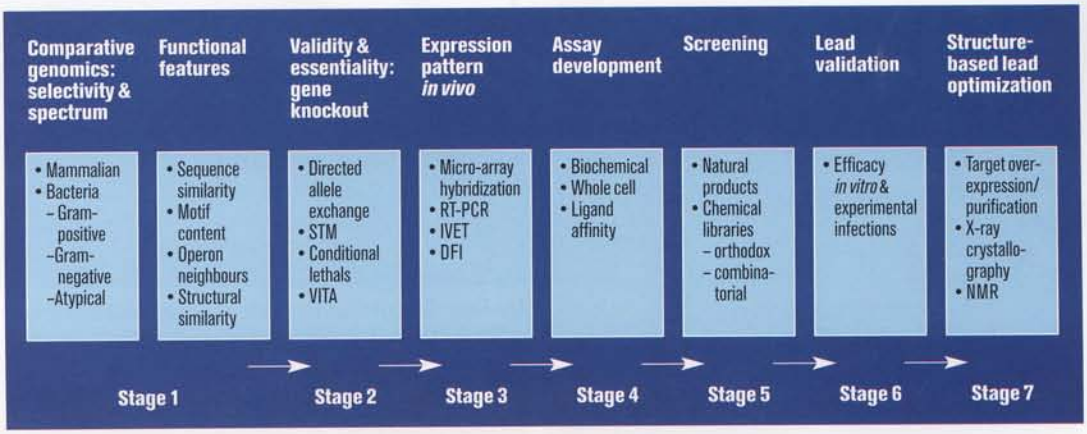
The ability to search for novel bacterial drug targets,

Table 2. Microbial genome sequencing projects either completed or under way in pathogenic micro-organisms (Mb)

1995	
	Haemophilus influenzae (1·83); *Mycoplasma genitalium* (0·58)
1996	
	Mycoplasma pneumoniae (0·81)
1997	
	Borrelia burgdorferi (1·3); *Escherichia coli* (4·6); *Helicobacter pylori* (1·66); *Mycobacterium tuberculosis* (4·4); *Plasmodium falciparum* Chr2 (1·0); *Staphylococcus epidermidis* (2·7); *Streptococcus pneumoniae* (2·2); *Treponema pallidum* (1·5); *Ureaplasma urealitycum* (0·75)
1998 on...	
	Aspergillus nidulans (29·0); *Bacillus anthracis* (4·5); *Bartonella henselae* (2·0); *Bordetella bronchiseptica* (4·9); *Bordetella parapertussis* (3·9); *Bordetella pertussis* (3·88); *Campylobacter jejuni* (1·7); *Candida albicans* (15·0); *Chlamydia pneumoniae* (1·0); *Chlamydia trachomatis* (1·0); *Clostridium difficile* (4·4); *Enterococcus faecalis* (3·0); *Giardia lamblia* (12·0); *Legionella pneumophila* (4·1); *Listeria monocytogenes* (3·2); *Mycobacterium avium* (4·7); *Mycobacterium leprae* (2·8); *Mycoplasma mycoides* (1·28); *Mycoplasma pulmonis* (0·95); *Neisseria gonorrhoeae* (2·2); *Neisseria meningitidis* (2·3); *Plasmodium falciparum* Chr1, 3, 4-14 (8·7); *Pneumocystis carinii* (7·7); *Porphyromonas gingivalis* (2·2); *Pseudomonas aeruginosa* (5·9); *Pseudomonas putida* (5·0); *Salmonella paratyphi* A (4·6); *Salmonella typhi* (4·5); *Salmonella typhimurium* (4·8); *Staphylococcus aureus* (2·8); *Streptococcus mutans* (2·2); *Streptococcus pyogenes* (1·98); *Treponema denticola* (3·0); *Vibrio cholerae* (2·5); *Yersinia pestis* (4·38)

Based on data in The Institute for Genomic Research website http://www.tigr.org

RIGHT:
Fig. 3. The genome-based preclinical drug discovery process. Abbreviations: STM, signature-tagged mutagenesis; VITA, validation *in vivo* of targets for anti-infectives; RT-PCR, reverse transcriptase PCR; IVET, *in vivo* expression technology; DFI, differential fluorescence induction.



or validate known potential targets, has been revolutionized by the advent of total genome sequence analysis and associated genetic techniques which are rapidly advancing our knowledge of numerous infectious agents. Thus between 1995 and 1999 some 20 microbial genome sequences were completed and another 50–60 are in progress (Table 2).

To exploit opportunities for drug discovery arising from large-scale microbial genome sequencing projects, computational and bioinformatic methods are required in the initial identification and selection of molecular targets, followed by a series of post-genome approaches to validate and characterize the targets, devise screens and pursue structure-based drug design (Fig. 3).

A particularly challenging issue for the first stage of the drug discovery paradigm will be the development of new algorithms to cope with some of the inadequacies of current methods to detect protein folds and functions from genomic data. Improvements in this area are likely to assist in the identification of novel genes with no known function or homology, which even in such thoroughly explored organisms as *Escherichia coli*, still account for over 20 % of the open reading frames.

When assigning functions to genes that constitute potential new drug targets, three broad categories will be identified; those required only for growth of bacteria in laboratory media (*in vitro* expressed genes), those required only for bacterial infection (*ivi* or *in vivo* induced genes) and those required for bacterial growth both *in vitro* and *in vivo* (housekeeping genes). Products of novel and essential genes falling into the second and third categories constitute new potential drug targets.

Conclusions

The discovery and development of antibiotics for the treatment of bacterial infections must be regarded as one of the most significant medical achievements of the twentieth century. Unfortunately, as we enter the new millennium many of our existing antibacterial agents are under threat from the widespread emergence of bacterial resistance. Furthermore, the pace of emergence of antibiotic-resistant bacteria has outstripped the discovery of new antibiotics. New agents are therefore urgently needed to counter the threats posed by antibiotic-resistant organisms. Genome-based approaches offer significant hope for the future by providing opportunities for target-based drug discovery rather than the empiric methods adopted in previous years. Furthermore, genome-based approaches should allow the selection of targets with a minimal potential for emergence of future resistance.

● *Ian Chopra is a Professor of Microbiology in the Division of Microbiology, School of Biochemistry and Molecular Biology, University of Leeds, Leeds LS2 9JT and Director of The Antimicrobial Research Centre at the University.*
Tel. 0113 2335604; Fax 0113 2335638
e-mail i.chopra@leeds.ac.uk

Further reading

Chopra, I., Hodgson, J., Metcalf, B. & Poste, G. (1997). The search for antimicrobial agents effective against bacteria resistant to multiple antibiotics. *Antimicrob Agents Chemother* 41, 497–503.

Knowles, D.J.C. (1997). New strategies for antibacterial drug design. *Trends Microbiol* 5, 379–383.

House of Lords Select Committee on Science and Technology (April 1998). *Seventh Report – Resistance to Antibiotics and Other Antimicrobial Agents*. London: HMSO. Also available on the web at http://www.official-documents.co.uk/

Moir, D.T., Shaw, K.J., Hare, R.S. & Vovis, G.F. (1999). Genomics and antimicrobial drug discovery. *Antimicrob Agents Chemother* 43, 439–446.

Chopra, I. (1999). Approaches for the discovery of new antibacterial agents. *Culture* 20, 3–6.

Allsop, A. (1999). Where are the new classes of antibiotics and antifungals going to come from? *Microbiol Today* 26, 166–167.

Meeting preview
Fighting infection in the 21st century
Petra Oyston

Microbiology has had a huge impact on our lives today. Think about what life would be like without the advances that the science has brought to the diagnosis, prevention and cure of infectious diseases. The Main Symposium, *Fighting Infection in the 21st Century*, at the Millennium Meeting, is being jointly organized by the SGM and the Society for Applied Microbiology (SfAM). Rather than looking back at past successes, this meeting aims to address some of the health issues facing microbiologists in the future.

Immunization has been one of the success stories of our time. Vaccination has protected us and our children against many of society's scourges and has even eliminated one disease completely – smallpox. C. Hendriksen (RIVM, The Netherlands) will review the progress of vaccine development to the modern day. Vaccines play a key rôle in our fight against disease but today they must not only provide protection, but must be safe and preferably given without the use of needles. Many strategies are being investigated to achieve this, whether by using attenuated strains that are able to invade from the gut, such as mutants of *Salmonella typhimurium* (M. Levine, University of Maryland, USA), or by expressing protective subunits, such as antigens in plants which may be eaten (G. Whitelam, Leicester University, UK) or DNA vaccines which can be administered through the skin using a gene gun (A. Hill, Oxford University, UK). The vast amount of data being generated by genome sequencing programmes will support and accelerate vaccine research in helping to identify both targets for attenuation and proteins for sub-unit vaccines.

So far only smallpox has been eliminated by mass global vaccination. The WHO hopes to add poliomyelitis to the list, but which other diseases can feasibly be targeted in a similar way? As the outbreak of plague in India recently proved, we ignore disease in the developing world at our peril. B. Mahy (CDCP, USA) will be discussing how infectious disease is a global issue in the era of long-haul flights, which allow infections to spread rapidly, and when the boundary between diseases of the developed and developing countries is becoming blurred. Also, changes in climate associated with global warming may result in pathogens and their vectors colonizing regions where they have previously not been found. Following the spread of disease will become more accurate by employing molecular techniques. M. Maiden (Oxford University, UK) will be describing a sequence-based approach, termed multi-locus sequence typing, which allows epidemiologists to follow bacterial lineages, identify clones and study bacterial populations. Finally, there is a more sinister threat to health: the ease of growing large quantities of micro-organisms has raised the spectre of pathogens being used by the unscrupulous as weapons of mass destruction, as was demonstrated by the concern during the Gulf War (P. Taylor, DERA, UK). In all these cases, we must develop prophylactic and therapeutic measures to protect people from disease.

One of the great advances of our time has been the development of antibiotics to treat infections. However, A. Tomasz (Rockefeller University, USA) will discuss how, due to complacency and misuse, existing antibiotics are becoming ineffective against common pathogens. New targets and new classes of antibiotics need to be developed, but this requires a better understanding of microbial biochemistry than we currently enjoy. Perhaps new classes of therapeutic agents will emerge to combat disease as a result of modern chemistry (F. Odds, Aberdeen University, UK) or we shall revisit under-exploited classes, such as the probiotics and bacteriophages (S. Bengmark, Ideon Research Centre, Sweden). In addition, therapeutic antibodies (E. Rietschel, AIBM, Germany) may have a place in the treatment of disease, in a modern approach to passive protection.

At the beginning of this century, improvements in public health and disease prevention had a dramatic impact on human well-being. In the developed world we take it for granted, for example, that water and food are safe to consume. When contamination occurs, such as *Cryptosporidium* in water, it has the potential to affect a great number of people. In less industrialized nations, water contamination is a serious, daily threat to health. As J. Bartram from the WHO (Switzerland) will discuss, an improvement in water quality in these countries would significantly improve people's health. With food production, the developed world is to some extent a victim of its own success. Intensive agriculture allows more food than ever before to be produced. Unfortunately, animals raised under intensive agricultural systems are highly susceptible to outbreaks of infection. To protect these animals, they are dosed with antibiotics, increasing the likelihood of resistant bacteria entering the food chain. It would be preferable to find alternative ways to protect farm animals from disease. In addition, we need to have processes in place to reduce the likelihood of our food being contaminated with pathogens and to detect any contamination that does occur so that unsafe food does not get eaten (T. Humphrey, PHLS, UK).

Whatever your area of interest, it is certainly an exciting time to be a microbiologist and this should be a thought-provoking session. In addition to the main symposium, a range of satellite meetings have been organized by the Groups of both societies to discuss some of these topics in more depth. For further details see the enclosed programme booklet or visit the meetings page of the SGM website at www.sgm.ac.uk

The Main Symposium will be published as a book.

● *Dr Petra Oyston helped to organize this symposium and can be contacted at CBD Porton Down, Salisbury SP4 0JQ*
Tel. 01980 613641; Fax 01980 613284
e-mail poyston@hotmail.com

A preview of the topics to be discussed in the Main Symposium at the joint SGM/SfAM Millennium Meeting at the University of Warwick, 10–11 April 2000

Other symposium organizers:
- *Professor P.W. Andrew, University of Leicester*
- *Professor G.L. Smith, University of Oxford*
- *Professor D.M. Stewart-Tull, University of Glasgow*
- *Dr M. Easter, Celsis International plc, Cambridge*
- *Dr P.M. Goodwin, The Wellcome Trust, London*

Forgotten microbiology – back to the future

Milton Wainwright

Microbiologists striving to solve problems in the 21st century could well find some answers in the publications of their predecessors...

University libraries all over the world are full of old scientific journals and books, left unread to gather dust. They are ignored largely because most scientists, including microbiologists, think that anything that is more than, say, 10 years old is not worth bothering with. Here, however, I want to suggest that these journals represent a huge resource of untapped knowledge, a view substantiated by numerous examples of where discoveries turn out to be independent re-discoveries. For example bacteria, including spiral forms, have long been isolated from stomach ulcers and antibacterial bismuth compounds have similarly long been shown to be effective in treating gastric ulcers. Imagine the suffering that could have been saved had these observations been acted upon before the mid-1980s when *Helicobacter pylori*'s causal rôle was discovered. Incidentally, bismuth was also used to treat rheumatoid arthritis and lupus erythematosus; could these diseases also be bacterial in origin?

The reasons why the older literature has often been ignored are varied and complex. One-off reports, for example, may just have been overlooked, or discoveries may have been dismissed because of opposition from a single, influential person. The minor unwritten law of science that '*one negative result (or a few) often outweighs many positives*' often operates, as it did in the case of mitogenetic radiation (an idea supported by a vast, international literature) that was effectively dismissed by a single negative report. The '*but everyone knows it is wrong*' response is often seen to be particularly damaging to new ideas, especially as it is often used by people who are ignorant of the relevant literature!

Of all the forgotten papers, those relating to the aetiology of disease are likely to be the most important. Some of the historical claims that bacteria cause diseases generally thought to be non-infectious, including cancer, rheumatoid arthritis and multiple sclerosis, are currently being re-evaluated, often with exciting results. What a tragedy it would be if the recent findings of Ebringer and co-workers, that rheumatoid arthritis and BSE have a bacterial aetiology, were, like much of the older literature, to be neglected for the best part of a century.

Filterable bacteria and extreme bacterial pleomorphism

Many microbiologists working during the early part of the twentieth century claimed that bacteria could pass through filters and then grow on standard media. These so-called filterable viruses were said to cause diseases, including rheumatism, arthritis, meningitis, influenza, the common cold and even cancer. When viruses (in the modern sense) were discovered the research effort shifted towards these agents and the exciting work on filterable bacteria slowly disappeared, only to reappear more recently in the modern guise of so-called nanobacteria. As early as 1917, the American scientist George Foster isolated a 'filterable virus' which, he claimed, caused colds; this turned out not to be a virus, but a filterable bacterium. Similarly, Olitsky & Gates isolated a filterable bacterium (0.15–0.3 µm, the so-called *Bacterium pneumosintes*) which, they claimed, caused a mild influenza-like infection predisposing the patient to pneumonia. During the 1920s and 1930s, it was also suggested that the massive death toll from the 1918 'flu pandemic resulted from synergism between viruses and bacteria (including filterable types).

Reports that cocci can change into rods and filaments and back again are a common feature of the early bacteriological literature and some workers even concluded that bacteria undergo life cycles, often with a hidden or filterable stage; a view given its modern expression in the fascinating book, *Cell Wall Deficient Forms* by Lida Mattman. As she points out, the rôle of bacterial L-forms in diseases such as cancer and arthritis is well worth a second look.

The cancer germ

For over a century, it has been claimed that highly pleomorphic, intermittently acid-fast bacteria cause cancer. It is a major disgrace that this literature has been ignored, especially since evidence was produced to show that tumour-isolated bacteria could be used to produce effective anti-cancer vaccines, and also cause tumours when injected into experimental animals. The historical finding that stomach cancer is associated with highly organic soils, together with the recent finding that *Helicobacter pylori* possesses amidases, typically found in soil bacteria, also suggests the possibility that 'cancer soils' may contain large numbers of this bacterium.

The sheer variety of non-virus isolates associated with cancer over the last century suggests that oncogenesis may well be a common ability amongst viruses and non-virus micro-organisms, working in concert with environmental and cellular factors, and genetic predeterminants.

Forgotten antimicrobial agents

The increase in antibiotic resistance amongst pathogenic bacteria has led many to speculate (perhaps prematurely) that we are approaching the end of the antibiotic era. Gene therapy is probably the favourite choice to replace antibiotics but, if desperate, we might also reconsider some historical approaches. For example, in the past, diseases were controlled by a variety of biocontrol agents, including bacteriophages, moulds and bacteria. Maggot therapy, the use of living fly larvae to treat infections, has recently made a spectacular comeback. Bacteria and viruses were also used to treat cancers and bacterial infections, so-called 'fever therapy' (where infections are given to induce a high fever).

Forgotten chemical approaches to disease control include the use of pectin and urea; urea, by the way, is naturally produced by fly larvae during maggot therapy. Extracts of organs (organ therapy) or bodily fluids, like bile, were also used against bacterial infections, while lysozyme was used to treat infections in Russia during the late 1930s.

Unpurified penicillin filtrates were also shown to have anti-tubercular, antidotal and even anti-tumour properties; by purifying penicillin we may therefore have thrown out a few babies with the bath water!

Action at a distance

The older literature suggests that micro-organisms can communicate using non-chemical signalling (i.e. action at a distance), the best example being by producing growth-stimulating, low intensity UV light (i.e. mitogenetic radiation). Micro-organisms have also been shown to grow towards metals, not ions, but lumps of metal, including iron and copper. Perhaps the best illustration of action at a distance is seen in the fungus *Phycomyes nitens*, which is attracted to iron, a phenomenon historically attributed (by Errera) to its ability to detect, and grow towards, water contained in the iron.

Panspermia and the origin of life

The eminent Victorian physicist, Lord Kelvin is usually credited with the view that life on Earth originated from space. More recently, the idea has been extended and popularized by Sir Fred Hoyle and Chandra Wickramasinghe. After years of being ridiculed, the views of these two scientists are now being taken more seriously; note, however, how their names are mysteriously omitted from recent articles on the subject! The soil microbiologist Jacob Lipman suffered much similar ridicule when he claimed that he had found bacteria in meteorites, a possibility which today is taken very seriously. Even the view, generally ascribed to Lynne Margulis, that cellular organelles are symbiotic accumulations of previously free-living organisms was once referred to as that *'old chestnut'*. Yet another recently resurrected, but old idea is so-called chemical photosynthesis (first described towards the end of the nineteenth century by Benjamin Moore), namely that ferric oxide and carbon dioxide, in the presence of light, yield formaldehyde, a precursor of life.

Conclusions

As I hope I have shown, there exists much forgotten, and often untested, literature relating to micro-organisms. How much of this is correct is obviously open to debate. Most microbiologists would, I assume, readily dismiss much of what I have discussed, perhaps with good reason, but I am sure that there is much of value here. Perhaps research councils and medical charities might even consider funding searches of the older medical microbiological journals to seek out forgotten research. The information could then be considered by what might be called 'hindsight committees'. I guarantee that these would prove far more productive than so-called 'foresight committees'.

Finally, if you think that microbiology cannot get much stranger, try reading the historical, and more recent, literature on paranormal microbiology which suggests that the human mind can influence the growth of micro-organisms.

Although limitations of space have allowed me to merely touch upon the forgotten literature, if only a small portion of what I have discussed is true then we are in for an exciting new millennium.

Dr Milton Wainwright is Senior Lecturer in Microbiology in the Department of Molecular Biology and Biotechnology, University of Sheffield, Sheffield, S10 2TN
Tel 0114 222 4410; Fax 0114 272 8697
e-mail m.wainwright@shef.ac.uk

Further reading

Mattman, L.H. (1993). *Cell Wall Deficient Forms*. Boca Raton, FL: CRC Press.

Wainwright, M. (1994). Biological control of microbial infections and cancer in humans: historical use to future potential. *Biocontrol Sci Technol* 4, 123–131.

Wainwright, M. (1995). The return of the cancer germ. *SGM Quarterly* 22, 48–50.

Wainwright, M. (1997). Extreme bacterial pleomorphism and the bacterial life cycle – a forgotten controversy. *Perspect Biol Med* 40, 407–414.

Wainwright, M. (1998). Historical and recent evidence for the existence of mitogenetic radiation. *Perspect Biol Med* 41, 565–571.

Wainwright, M. (1999). Nanobacteria and associated 'elementary bodies' in human disease and cancer. *Microbiology* 145, 2623–2624.

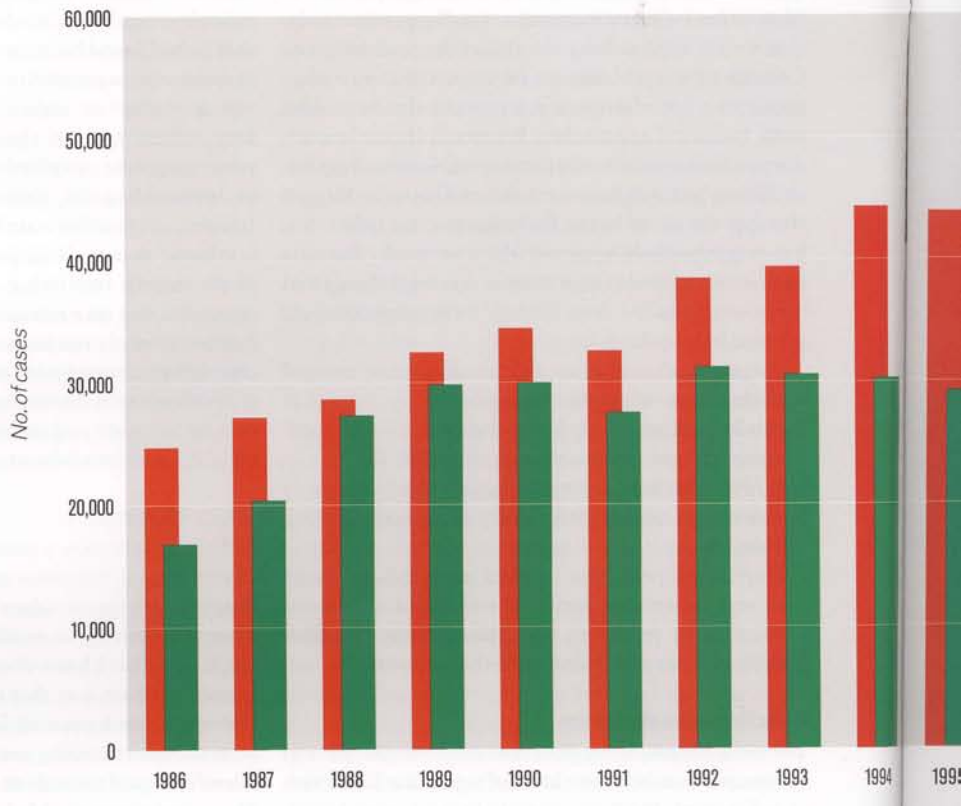
Fit to eat?
Food scares and safe food production

Tom J. Humphrey, Karen L. Mattick & Frieda Jørgensen

The level of food-borne infections is unacceptably high. What strategies are being developed to combat this situation? And what is current research revealing?

Over the last century, public health in the developed world has undergone a revolution. Outbreaks of diseases such as typhoid, spread mainly by contaminated water, are now relatively rare. This has largely been achieved through improvements in hygiene and sanitation but also by intervention in the form of vaccination. As we move into the next millennium, it is important to acknowledge the progress already made, but also to highlight infections of current and future importance. The incidence of *Campylobacter* and *Salmonella* infection in England and Wales has rarely been higher and, in the case of *Campylobacter* at least, continues to rise (Fig. 1). Recent studies have demonstrated that approximately 1 in 5 of the population of England and Wales will have an episode of infectious intestinal illness each year, costing a total of £0.75 billion.

Fig. 1. Recent trends in *Salmonella* (■) and *Campylobacter* (■) infection in E



Most food-borne infections are not life-threatening and treatment will normally comprise bed rest and maintenance of fluid intake only. With certain bacteria such as verocytotoxin-producing *Escherichia coli* O157:H7, however, mortality can be as high as 40%, particularly when the elderly are infected. At present in England and Wales there are approximately 1,000 cases of *E. coli* O157 infection each year. Infection with certain strains of *Campylobacter jejuni* is now recognized as an important predisposing factor for Guillain–Barré Syndrome. Each year in England and Wales, *Salmonella* infection is responsible, either directly or indirectly, for 70–100 deaths.

Given the above, and the often very large outbreaks of food-borne infection that occur, there is much media and public interest in food safety. This has led, indirectly, to the appearance of a new and popular phrase – the 'food scare'. A scare is defined as '*alarm caused by rumour*', or '*a sudden attack of fright*' (Pocket Oxford Dictionary). Food scares are becoming increasingly commonplace and there is a need to inform the public of potential risks, whilst avoiding food scares. This could be achieved by highlighting relative risks and emphasizing that there will always be some level of risk, however small. Such an approach is difficult, as people are reluctant to accept any risk in relation to food.

Why has food poisoning increased?

Many questions regarding food poisoning remain unanswered. Why is it so common? What are the factors responsible for the predominance of *Campylobacter* and *Salmonella* spp. as human pathogens? Why has *E. coli* O157:H7 appeared? And what measures can we take to reduce the incidence of food poisoning?

A variety of factors are responsible for the marked increase in food poisoning over the last decade, and improved laboratory isolation techniques and surveillance could explain some of the increase. Food poisoning case identification has certainly improved and there is also increased awareness of food-borne disease. This alone cannot account for the rise in certain sub-populations of *Salmonella* spp., for example *Salmonella enteritidis* phage type (PT) 4 which is associated with chickens or *Salmonella typhimurium* definitive type (DT) 104, which has multiple antibiotic resistance. Laboratory techniques do not discriminate for or against specific *Salmonella* spp. – these are real increases.

Intensification of food production

Food production, processing and preparation constantly change to meet consumer demands. At the same time there is pressure on the food and agricultural industries to produce food as cheaply as possible. This is being driven, principally, by intense competition between food retailers and the increasing globalization of the food supply. Poultry meat and eggs are important and valuable sources of protein, and both have become significantly cheaper, in relative terms, over the last 10–20 years as a consequence of intensification of production. The great majority of the billion chickens consumed in the UK each year are produced using the 'broiler' system, with broiler houses routinely containing many thousands of birds (Fig. 2). For bacterial pathogens such as *C. jejuni*, optimal transmission results when many susceptible hosts are in the same place at the same time. Chicken production provides these conditions and work in our laboratory has demonstrated that all chickens tested became colonized within 2 days of the appearance of *C. jejuni* in the flock (17,000 birds). Poultry processing has a high throughput, with modern plants processing up to 200 birds per minute. This facilitates cross-contamination and it is perhaps not surprising that over 75% of chicken carcasses on retail sale are *Campylobacter*-positive.

The challenge for the industries involved is to deliver these foods to the consumer as free from pathogens as possible. Advances are being made and the fall in *Salmonella* infections seen recently in the UK (Fig. 1) has been partly attributed to vaccination of laying flocks by the major egg producers. However, such measures cost money and it is important that food safety is not compromised in the drive for ever cheaper foods.

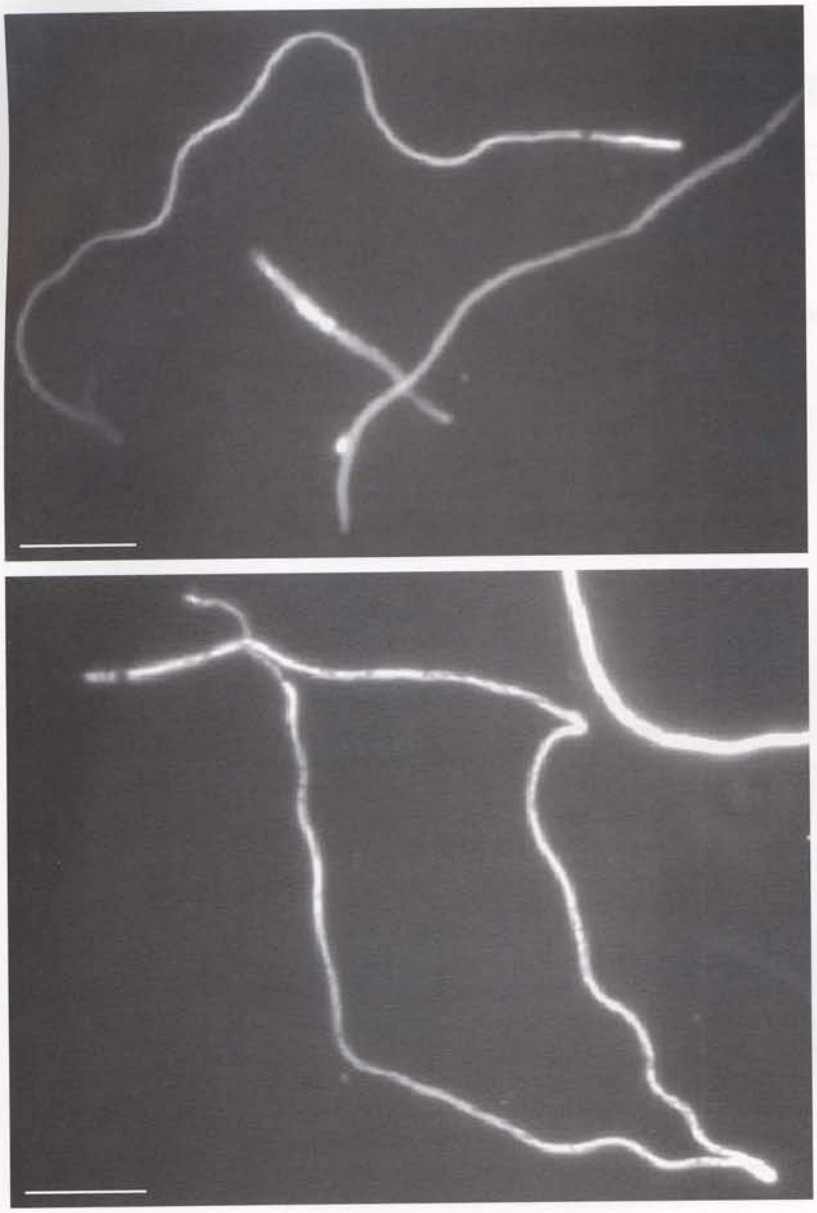
The consumer and food safety

Food safety is a responsibility shared by producers, processors, retailers and consumers, and intervention should be targeted at all levels. Although food poisoning is often associated with large-scale catering, most cases are either sporadic or part of family outbreaks and the issue of food hygiene in the home must be addressed, but not over-emphasized. The international scientific community considers that problems of food contamination are best addressed by adopting a 'farm-to-fork' approach, i.e. by tackling the problem at many points in the food chain. This includes consumer education, such as highlighting the hazards of eating raw eggs and undercooked chicken. Cross-contamination is recognized as an important contributory factor in approximately 30% of domestic outbreaks of *Salmonella* infection. Research in Exeter has shown that the preparation of a meal containing chicken can lead to the widespread dissemination in the kitchen of cells of *Campylobacter* and *Salmonella* spp. naturally present on carcasses. Such spread is difficult to control and once present in the kitchen environment, these bacteria persist and may contaminate foods either directly or via contaminated hands. This, often inadvertent, spread suggests that the control of chicken-associated human infection is best tackled at farm level.

Bacterial evolution

Food-borne pathogens like *Salmonella* mount stress responses to the many different environments found in food production. These responses can be very rapid and are often mediated by the regulatory gene *rpoS*, which encodes the sigma factor RpoS (regulatory protein of stationary phase). Bacterial populations continually evolve and certain *Salmonella* strains can mutate at an unusually high rate. Whether mutator strains give an overall advantage is still uncertain but mutator strains of *Salmonella* and *E. coli* are more common than previously thought.

BELOW:
Fig. 2. Broiler chickens at slaughter weight.



ABOVE:
Fig. 3. Filamentous multi-nucleate *Salmonella typhimurium* DT104 cells after 14 days incubation at 6 °C. Bars, 5 µm.

The pressure from the consumer for less heavily preserved foods has the result that safety margins are narrowing. The food industry employs numerous methods to preserve foods during processing and to ensure that pathogens do not survive in sufficient numbers to cause disease. These methods include heating, pH reduction or reducing the a_w by drying or by incorporating solutes such as salt or sugar. Often such methods are combined sequentially in a process called microbial hurdle technology; thus food manufacturers can reduce the severity of each sequential treatment to achieve the same reduction in micro-organisms, without compromising the organoleptic quality of the food. It has been postulated, however, that an organism surviving the sequential stresses may be physiologically prepared for optimal virulence. The same regulatory gene (*rpoS*) that enables an organism to survive exposure to environmental stress is also involved in virulence. In addition, novel food processing regimes may allow survival of a different subset of strains, and will therefore need on-going evaluation.

Recent research has highlighted possible potential hazards associated with the trend towards milder processing, in terms of pathogen survival and the physiology of surviving bacteria. Our laboratory has demonstrated that at refrigeration temperatures, some *Salmonella* spp. can form long filaments (Fig. 3). The organism continues to increase in biomass but cannot divide as usual. When the stress is removed by raising the temperature, the filaments complete division and a rapid increase in bacterial numbers results. The implications associated with this phenomenon are currently being investigated.

For the future, a better appreciation of the ecology of micro-organisms throughout the whole food chain will be needed. Further research into the physiology of organisms more able to withstand the stresses used in hurdle technology and to survive in the environment is required.

● *Tom J. Humphrey is Head of the PHLS Food Microbiology Research Unit, Church Lane, Heavitree, Exeter EX2 5AD*
Tel. 01392 402955; Fax 01392 412835;
e-mail: T.J.Humphrey@exeter.ac.uk
● *Frieda Jørgensen is a Grade B clinical scientist and Deputy Head of the Unit*
● *Karen L. Mattick is a Grade A clinical scientist and is doing a PhD on stress responses in Salmonella*

Not to be sniffed at

T.D. Gibson, J.N. Hulbert, O.C. Prosser & A.K. Pavlou

Tim Gibson and colleagues describe the development of electronic noses for rapid, sensitive detection and diagnosis of microbial infections.

The diagnosis of disease states is a primary pre-requisite of successful medical treatment and as such is a high priority in any area of clinical science. Microbial infections and related causes of illness seem to be one of the more common problems encountered in the world today and are widely reported by the press, especially when so-called 'killer bugs' or 'antibiotic-resistant' organisms are mentioned.

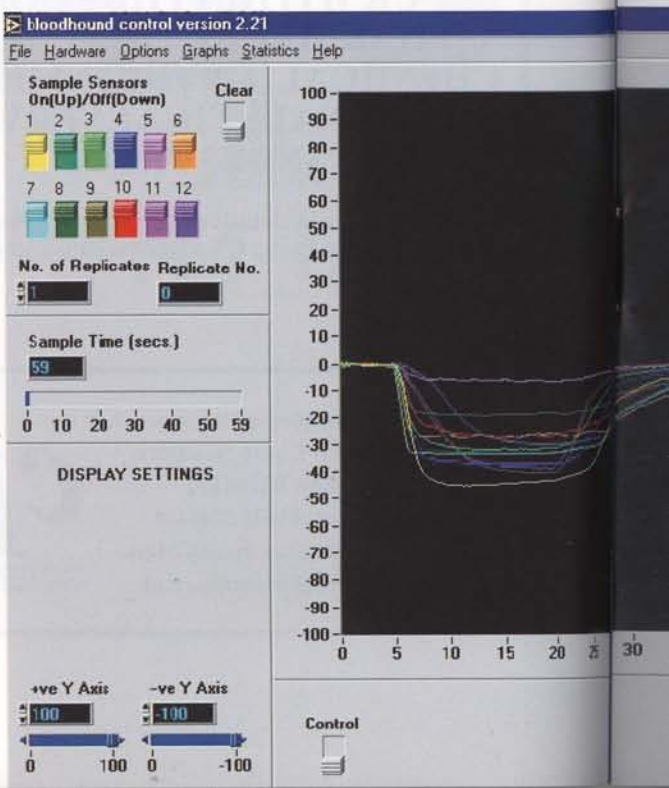
In many cases, infection with micro-organisms produces a change in the smell of a person, which can be especially noticeable on the breath, in the urine or the stools. Such changes have been commonly used as an aid to diagnosis of disease and in some countries, smelling the patient or the body fluids of the patient was, and still is, an important tool in diagnosis. In 1986, *National Geographic* published an article on 'The intimate sense of smell' in which the odour of different diseases was described and in which clinicians state that odour is important in diagnosis, especially in the emergency room.

Smells and disease

There are a number of specific publications detailing smell as one of the major aids in determining correct clinical diagnosis. Maple syrup urine disease is a well known condition that is characterized by a sweet aroma in the urine of affected patients. The cause in this case is not infection, but a defect in the branched-chain amino acid metabolism, leading to excretion of sotolone, a flavour impact compound that is present in fenugreek and lovage. Schizophrenia has been reported to be characterized by the appearance of volatile compounds in the breath of patients, which may be used to indicate the condition. The characteristic odour appearing in the breath of these patients seems to be due to changes in fatty acid metabolism. A very recent report has indicated that lung cancer may be identified using GC-MS analysis of 22 volatile organic compounds in the breath of patients. These compounds have been identified as mainly alkanes, alkane derivatives and benzene derivatives. Urinary tract infection by enterobacteria has been diagnosed by headspace GLC analysis of urine and other workers have detected anaerobic bacteria in blood cultures using GLC methods.

Electronic noses

Over the last few years, the development of instruments that detect and digitally characterize smells by electronic means have been well reported in both the scientific and the topical literature. These instruments, which use arrays of chemically sensitive sensors, have been colloquially dubbed 'electronic noses'. Basically they produce a digital response to a complex odour or smell that may then be used to identify or describe that odour by some sort of definitive measure. They are not, in the accurate sense of the term, analytical instruments, but are more comparative in their use and deployment. A recent book by Gardner & Bartlett covers the basic



TOP RIGHT:
Fig. 1. The Bloodhound BH 114 instrument is based on conducting and semi-conducting polymer sensors and is designed to be versatile, with a rapid sampling time (usually less than 1 minute). The sensor arrays produce signals from a wide range of volatile organic compounds and are stable and reversible in nature, allowing instrument use over periods of several months or even years. A recalibration facility is available and the instrument is fairly compact, weighing approximately 2·8 kg. The instrument is fully software-controlled and allows some integral data processing and data export to more sophisticated processing packages.

BOTTOM RIGHT:
Fig. 2. Profiles of headspace odour taken in 'effective real time'. The sampling window of the BH 114 in this example is set to 60 seconds, with a 15 second pulse of headspace sample over the 14 sensors. Each sensor responds individually to the volatile compounds contained in the sample to give a unique pattern of responses that can then be further processed using statistical or neural network techniques.

principles of electronic noses and the current methods available, with a number of application areas described.

As an example of an electronic nose, a Bloodhound BH 114 instrument, which is based on an array of 14 conducting and semi-conducting polymers with varying sensitivity to volatile organic compounds, is shown in Fig. 1.

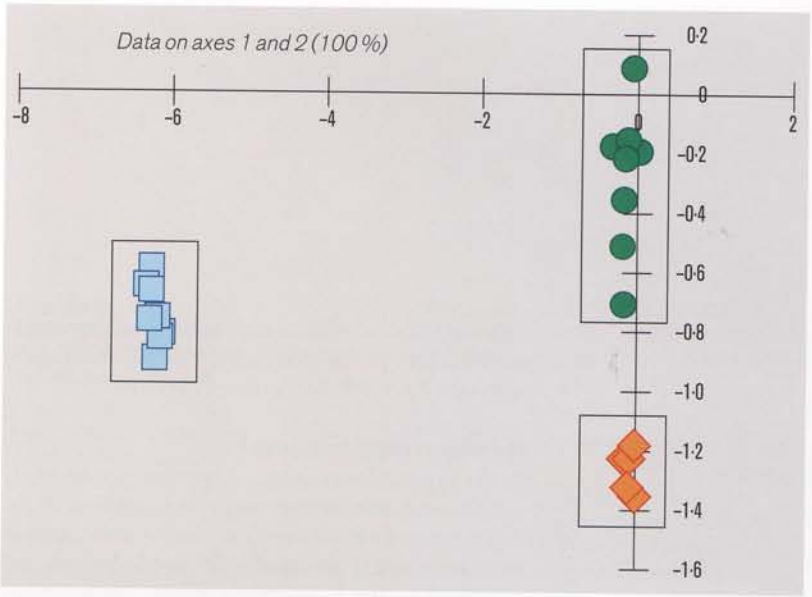
The actual traces from a sample can be seen in Fig. 2, where 14 sensors are responding in 'effective real time' to give a unique pattern of responses to the odour of bacteria. The different parameters such as peak height, rate of adsorption, rate of desorption and area under the curve are then processed using statistical methods or neural network techniques to give a 'digital fingerprint' and thus identify the bacteria producing the odour.

Applications in microbiology

In the past few years various groups and companies have been experimenting with electronic noses in the detection of microbial growth. It is a logical progression to look at the incidence of infection by micro-organisms using changes in the smell of the patients themselves or the odour of clinical samples. Further to this idea, the combination of selective culturing techniques currently used and the subsequent measurement of the odours generated could be used to identify the causative organisms in clinical infections more quickly.

In 1996, a project to discriminate between bacteria in culture was carried out by Bloodhound Sensors Ltd in collaboration with Oxoid Ltd. This work indicated that it is possible to simultaneously detect bacteria and to identify them by smell. The rapidity of the culturing and sampling to produce results was reduced to a single working day, with a 4–6 hour incubation period being sufficient to produce the characteristic odours associated with bacterial growth. Table 1 shows the results for a number of bacterial species and strains that were used to train a neural network. Identification of these species was carried out to a 95% confidence match. It can be seen that in all cases the identification was successful.

Headspace odour samples were generated by plates in sealed bags or by sparging through liquid medium. Published research on bacterial detection by electronic noses includes the screening of bacterial vaginosis, microbial contaminations in bioprocesses and detection and simultaneous identification of bacteria in culture.



ABOVE:
Fig. 3. Detection of *Helicobacter pylori* in artificial stomach atmospheres, showing discriminant analysis scores and formation of three separate clusters. An artificial stomach atmosphere containing *H. pylori* and biochemical inducers (■) has produced a completely different odour profile. Although sterile artificial stomach (●) and *H. pylori* normal growth (◆) are closer, there is still a clear distinction between them.

Recently, workers at Cranfield University have been able to show the utility of an electronic nose (Bloodhound BH 114) to diagnose *Helicobacter pylori* infections. Inclusion of biochemical inducers results in an improvement in the discrimination patterns. Results using a genetic algorithm/neural network classification method are shown graphically in Fig. 3.

The electronic nose methodology used to detect and diagnose bacterial infection is growing, with some of the latest results showing that TB infection can be rapidly diagnosed using odours generated from sputum samples. Again, a BH 114 electronic nose was used to sample the volatiles from the headspace of the sputum. The experimental set-up is shown in Fig. 4 and the results were analysed using the same genetic algorithm/neural network method used for the *H. pylori* study (Fig. 5). This method of rapid, non-invasive

Table 1. Identification of bacterial species and strains using neural network techniques

Bacterial species / strain	Percentage correct classifications
Control plates	100
Control liquid media	100
Distilled water blank	100
Escherichia coli 10418 (plate)	100
Escherichia coli 10418 (liquid culture)	100
Escherichia coli M1 (plate)	100
Escherichia coli M1 (liquid culture)	100
Proteus mirabilis (plate)	100
Proteus mirabilis (liquid culture)	100
Pseudomonas aeruginosa 10662 (plate)	100
Pseudomonas aeruginosa 10662 (liquid culture)	100
Pseudomonas aeruginosa 510 (plate)	100
Pseudomonas aeruginosa 510 (liquid culture)	100
Staphylococcus aureus (plate)	100
Staphylococcus aureus (liquid culture)	100

identification of TB could have very important ramifications in the global detection of this disease, especially if portable devices can be developed.

Future developments

In the future, devices like electronic noses are likely to become much more versatile and common in the detection and identification of clinical infections. It may be possible eventually to sense diseases and infections in the field using portable, miniaturized instruments. Already, small battery-operated detectors for breath analysis are available and battery-operated prototype electronic noses have been constructed. Also, as sensor technology becomes more advanced, different types of simplified detection principles will emerge. A new technique, termed pulse spectroscopy, is being developed by Bloodhound Sensors Ltd, which uses a single sensor to give a response trace similar to GC-MS, but over timescales of a few seconds. This method may supercede the more traditional electronic noses and make the detection and identification of bacterial infection a much simpler task than it is at present. The crucial need for inexpensive diagnostic tools will continue apace and as technology develops at an alarming rate, the appearance of a *Star Trek* 'tricorder' device may not be too long in coming.

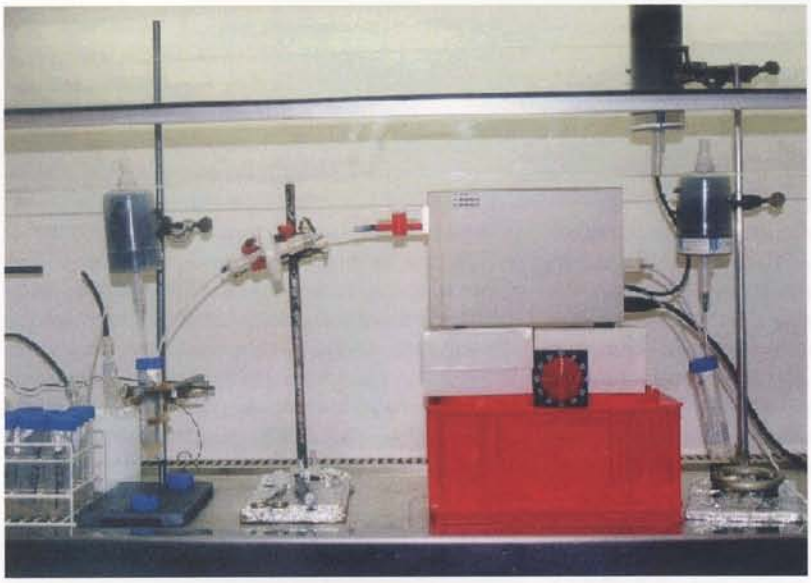


Fig. 4. Apparatus for detection of TB in sputum. The Bloodhound BH 114 electronic nose samples the volatiles from a sputum sample through a filter to prevent instrument contamination. Large carbon filters are used to scrub incoming air so that only odour from the sample is recorded. Calibration headspace for instrument recalibration is generated at the rear of the machine.

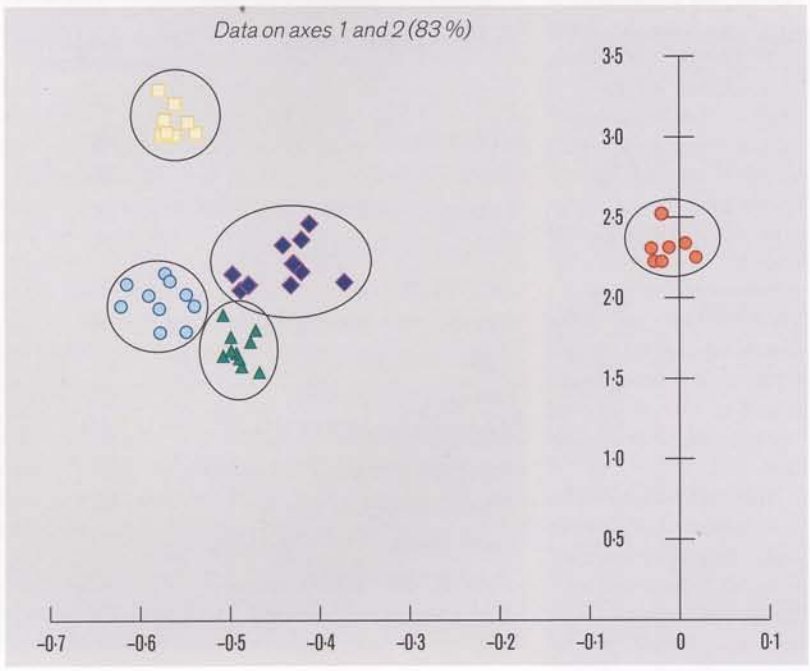


Fig. 5. *Mycobacterium tuberculosis* (▲, 10 samples), *Mycobacterium avium* (◆, 10 samples), *Pseudomonas aeruginosa* (●, 10 samples), mixed infection (●, 8 samples) and normal/control sputum (●, 8 samples) were collected and sampled. The data were processed using a genetic algorithm/neural network technique and the results presented in the graph are based on discriminant analysis of the processed data. It can be clearly seen that the different bacterial infections produce separate clusters using this method, even to the extent that mixed infections can be discriminated from single organism infections. The data generated here were from an instrument that has been in use for over 2 years.

● *Dr Tim Gibson (corresponding author) is Research Director at Bloodhound Sensors Ltd, 175 Woodhouse Lane, Leeds LS2 3AR*
Tel. 0113 233 2599
Fax 0113 233 2593
e-mail t.d.gibson@leeds.ac.uk

● *Mr John Hulbert is Managing Director of Bloodhound Sensors Ltd*
Tel. 0113 233 3429
Fax 0113 233 3433
e-mail j.n.hulbert@leeds.ac.uk

● *Miss Olivia Prosser is Project Manager at Bloodhound Sensors Ltd*
Tel. 0113 233 3439
Fax 0113 233 3433
e-mail o.c.prosser@leeds.ac.uk

● *Mr Alex Pavlou is a final year Postgraduate Student at Cranfield Postgraduate Medical School, Cranfield University, Bedfordshire MK43 0AL*

Letters

Further reading

Chandiok, S., Crawley, B.A., Oppenheim, B.A., Chadwick, P.R., Higgins, S. & Persaud, K.C. (1997). Screening of bacterial vaginosis: a novel application of artificial nose technology. *J Clin Pathol* **50**, 790–791.

Dodd, G.H. (1999). The lipid membrane hypothesis of schizophrenia: implications for possible clinical breath tests. *Prostaglandins Leukot Essent Fatty Acids* **55**, 95–99.

Gardner, J.W. & Bartlett P.N. (1999). *Electronic Noses: Principles and Applications*. New York: Oxford University Press.

Gibbons, B. (1986). The intimate sense of smell. *National Geographic* September, 324–361.

Gibson, T.D., Prosser, O., Hulbert, J.N., Marshall, R. W., Corcoran, P., Lowery, P., Ruck-Keene, E.A. & Heron, S. (1997). Detection and simultaneous identification of micro-organisms from headspace samples using an electronic nose. *Sensors & Actuators* **B44**, 413–422.

Heyward, N.J. (1983). Headspace gas liquid chromatography for the rapid laboratory diagnosis of urinary tract infections caused by Enterobacteria. *J Chromatogr* 274, 27–35.

Namdev, P.K., Alroy, Y. & Singh, V. (1998). Sniffing out trouble: use of an electronic nose in bioprocesses. *Biotechnol Prog* 14, 75–78.

Pavlou, A.K., Magan, N., Turner, A.P.F., Sharp, D., Brown, J. & Barr, H. (2000). An *in vitro* rapid odour recognition model in discrimination of *Helicobacter pylori* and other gastro-esophageal pathogens. *Biosens Bioelectron* in press.

Pavlou, A.K. & Turner, A.P.F. (2000). Sniffing out the truth: clinical diagnosis using the electronic nose. *J Clin Chem Lab Med* in press.

Phillips, M., Gleeson, K., Hughes, J.M.B., Greenberg, J., Cataneo, R.N. & Baker, L. (1999). Volatile organic compounds in breath as markers of lung cancer: a cross sectional study. *Lancet* 353, 1930–1933.

Podebrad, F., Heil, M., Reichert, S., Mosandl, A., Sewell, A.C. & Bohles, H. (1999). 4,5-Dimethyl-3-hydroxy-2[5H]-furanone (sotolone) – the odour of maple syrup urine disease. *J Inherit Metab Dis* 22, 107–114.

Reig, M., Molina, D., Loza, E., Ledesma, M.A. & Meseguer, M.A. (1981). Gas liquid chromatography in routine processing of blood cultures for detecting anaerobic bacteremia. *J Clin Pathol* 34, 189–193.

Article in *Microbiology Today* Vol. 26/4, November 1999, pp. 172–173

I was interested to see the article in *Microbiology Today* by Peter Balfe and wish to offer a few observations which I hope will be of interest.

I would suggest that the headline to the article is misleading – to the best of my knowledge, Lady Mary Wortley never advocated vaccination per se – as the article makes clear, she was in favour of variolation. The '*leap in the dark*' was to use cowpox virus as the inoculum and then follow this by challenge with smallpox (Variola) virus. I would certainly agree that Edward Jenner was not really taking such a 'giant leap', since it could be argued that, by challenging with Variola post-Vaccinia inoculation, he was only 'hedging his bets' to variolate in case the vaccination did not work!

I don't know whether readers are familiar with the story of Benjamin Jesty, a Dorset farmer – I believe that he was the first 'vaccinator', who vaccinated his family with cowpox in 1774 – 22 years before Jenner. (See http://home.sprynet.com/~btomp/smallpox.htm for details of the story, which I think was probably taken from a small booklet entitled *The First Vaccinator* published by Dorset County Museums in about 1970.)

The only thing that Jenner did and Jesty did not was to challenge his vaccinees with Variola afterwards, probably believing that they would be immune anyway – this seems to have been a common country belief at the time.

■ *Malcolm Losson, Biological Safety Officer, The University of Reading, Safety Office, Room 111A, Physics, Whiteknights, Reading, Berkshire, RG6 6AF Tel. 0118 931 8888; Fax 0118 931 6765; e-mail m.losson@reading.ac.uk*

Microbiological aspects of wastewater treatment and reuse in developing countries

Wastewater treatment in developing countries needs to be low-cost, easy to operate and maintain, and, in most cases, produce an effluent that can be safely used for crop irrigation and/or fish culture. The most appropriate treatment technologies are usually (i) waste stabilization ponds (WSP), one or more series of anaerobic, facultative and maturation ponds, or (ii), in water-short areas, wastewater storage and treatment reservoirs (WSTR), or (iii) a hybrid WSP–WSTR system.

● WSP anaerobic ponds are low-rate anaerobic reactors, but nonetheless very efficient (over 70 % BOD removal at 25 °C). Facultative and maturation ponds are photosynthetic reactors with green algae providing the oxygen for bacterial BOD removal. The algae also create optimal conditions for the rapid die-off of faecal bacteria.

● WSTR permit the whole year's wastewater to be used for irrigation, rather than that just produced in the irrigation season, so enabling a greater area of land to be irrigated and more crops produced. The hybrid WSP–WSTR system also allows this to be done with half the year's wastewater treated and used for restricted irrigation and the other half for unrestricted irrigation.

● Reuse quality guidelines. For restricted irrigation the WHO guideline is one human intestinal nematode egg per litre treated wastewater. For unrestricted irrigation there is the additional guideline of 1000 faecal coliforms per 100 ml treated wastewater. For wastewater-fed fishponds the guidelines are an absence of human nematode eggs and 1000 faecal coliforms per 100 ml fishpond water. Properly designed WSP and WSTR can easily achieve these levels. For restricted irrigation and fish culture often only anaerobic and facultative ponds are necessary, whereas for unrestricted irrigation, maturation ponds are needed.

■ *Professor Duncan Mara, School of Civil Engineering, University of Leeds, Leeds LS2 9JT e-mail d.d.mara@leeds.ac.uk*

Microbial solvent abuse – a legally encouraged practice!

Ajay Sharman & Cliff Burton

Scientists are increasingly exploiting the ability of microbes to clean up environmental pollution. Ajay Sharman and Cliff Burton describe the development of a novel bioremediation system to treat waste solvent in the footwear industry.

ABOVE:
Fig. 1. Active biomass inside a BIOVOX® reactor.
COURTESY VIRIDIAN EHC LTD

Microbiology needs bioprocess engineering

The enormous diversity and capabilities of micro-organisms to degrade and to transform a wide range of pollutants in nature, whether organic or inorganic is well known. There are also considerable efforts being undertaken globally to elucidate metabolic pathways, improve substrate turnover and generally speed up and expand the capacities of microbial biotechnology. It turns out that the drivers to move this established science into the marketplace are not primarily microbiological, but a combination of engineering and economics, the latter being driven at least in part by changes in environmental legislation.

Environmental biotechnology has steadily become a recognized and crucial discipline in the fight against pollution, whether applied to pollution in air, land or water. It has consistently shown in principle that it offers technical advantages and cost benefits, but in practice has delivered only a fraction of its potential. There have been many barriers to the commercialization of environmental biotechnology applications which include:

Research barriers – difficult recalcitrant organic and inorganic molecules, pH, high temperatures, metal toxicity;

Regulatory barriers – regulations dictate the economics, encouraging uptake of cost-effective technologies;

New technology barriers – environmental biotechnology applications are regarded as 'new' technology, untested and innovative with a degree of risk.

Commercial markets are dominated by physical and chemical approaches and one of the more important barriers to the successful implementation of technically proven bioprocesses is ensuring adequate and robust bioprocess engineering. The sequence of conceiving a new bioprocess, developing a consortium of micro-organisms capable of pollutant biodegradation, developing an efficient operation in which to install the consortium for maximum activity and all the while having to meet marketing timetables and budget constraints is always stimulating and holds a number of surprises. There are periods of excitement and pressure in the achievement of bringing a new bioprocess to full-scale, on-stream and operation. This was very much the case in the development, design and full-scale build by Viridian EHC Ltd ('Viridian') of a novel patented technology, BIOVOX®, to treat hazardous volatile organic compound (VOC) emissions.

VOCs – the legislative driver

There is worldwide interest concerning the pollution potential arising from the use of solvents in industry. Traditionally those concerns have directed attention to odour issues by the general public around users' premises. Whilst this continues to be important, the air pollution debate has focused much greater attention on the emission of VOCs specifically. The potential health effects of VOC emissions, although of enormous concern, have arguably been superseded by the debate of the rôle of VOCs in tropospheric ozone depletion.

The emission of VOCs is generally controlled by national legislation (UK), an EU Directive (1998) and the United Nations Economic Commission for Europe (UNECE) VOC protocol. The EU approach is to meet air quality standards through a combination of proposed and adopted Directives which include measures on power generation and transport as well as the Solvent Emissions Directive (SED). The most significant of these are the Integrated Pollution Prevention and Control (IPPC) Directive and the Auto/Oil programme. In December 1999 a new international protocol to cut levels of air pollution across Europe and North America over the next 10 years was signed in Gothenburg, Sweden. The agreement is designed to achieve reduction in four atmospheric pollutants, including VOCs, by 2010. The total anthropogenic VOC emission in the UK alone is estimated at close to 3 million tonnes annually. In June 1998 in the UK, companies using solvent in excess of the permitted quantities were required to meet an emission limit of either 50 mg C m^{-3} (using approximately 15 tonnes per year) or 150 mg C m^{-3} (using approximately 5–15 tonnes per year), or to comply with stringent industry sector-specific mass-emission control regimes.

BIOVOX® – the development phase

Viridian, an environmental biotechnology company specializing in the treatment of polluted air, land and

LEFT:
Fig. 2. A pilot-scale BIOVOX® system at R. Griggs and Company Ltd, Wellingborough.
COURTESY VIRIDIAN EHC LTD

water, developed a novel biological treatment system for the destruction of VOCs in air emissions. Biological off-gas treatment is generally based on the absorption of the VOC in the waste gases into the aqueous phase followed by direct oxidation by a wide range of voracious bacteria, which include *Nocardia* spp. and *Xanthomonas* spp. A number of generic biotreatment systems exist, namely biofilters, biotrickling filters and bioscrubbers – the application and selection of which depends on the solubility of the VOC components.

A project partly co-funded by the BOC Foundation for the Environment and the Department of Trade and Industry (DTI) [under the Biotechnology Means Business (BMB) Initiative] was proposed and technically managed by Viridian. The project was aimed at solvent-using companies for two reasons: (a) to implement a biotechnological solution to overcome legislative pressure on solvent emissions; and (b) to improve the overall competitiveness of the companies' problems by securing a more cost-effective solution to environmental air emission. The footwear industry was recognized as a major user of solvents and as a consequence the SATRA Technology Centre, Kettering, the largest independent research and technology organization in the world, was approached. SATRA is supported by member companies associated with the UK footwear industry and addresses concerns over solvent emissions and general environmental issues.

Viridian conceived a novel approach to waste solvent emissions from off-gases and, as part of a 14-month development phase, had four key objectives to fulfil:

- Engineering review and laboratory study;
- Footwear manufacturing site location and initial VOC monitoring;
- Pilot-scale demonstration on-site;
- Full technical and economic assessment.

After detailed and extensive evaluation, design and development studies at Viridian, an innovative biotreatment configuration (now known as BIOVOX®) was developed. Patents have been filed for the technology. The system is a hybrid technology combining the benefits of both biotrickling filters and biofilter technologies but is novel in design and operation: in essence it mineralizes the VOCs completely. The consortium of micro-organisms rapidly biodegrades marginally water-soluble solvents at ambient temperature and neutral pH. Within the system, the consortium grows as an active biofilm on a mixed media support through which the solvent vapour is circulated. An inert medium was found to be highly effective in (a) providing a high surface area to allow effective contact between the vapour phase and the liquid phase, as liquid is recirculated within the reactor to solubilize solvents from the contaminated inlet gas, and (b) safe, non-toxic support for the active biofilm. Water and nutrients are uniformly sprayed across the active biofilm (Fig. 1).

Following the success of the laboratory phase and after securing an appropriate location for a pilot-scale

Fig. 3. Inlet (■) and outlet (■) VOC concentrations after commissioning

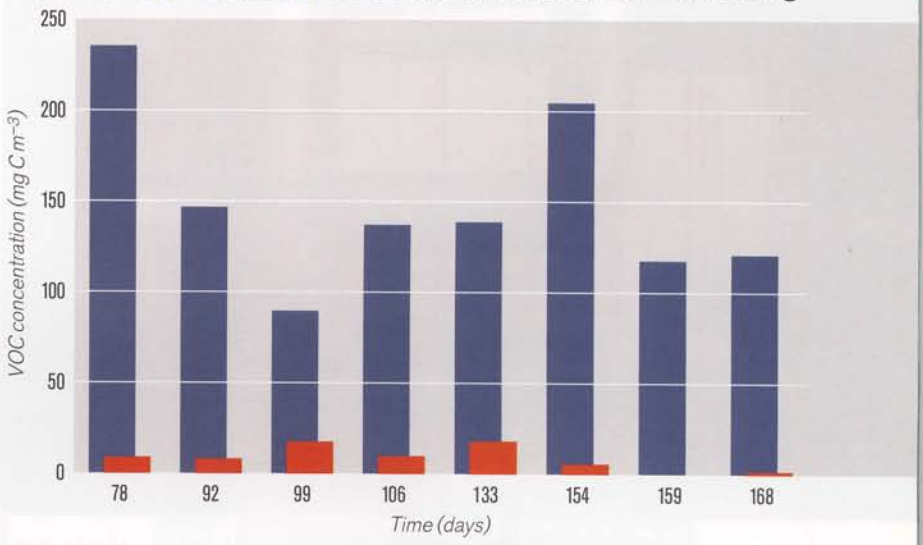
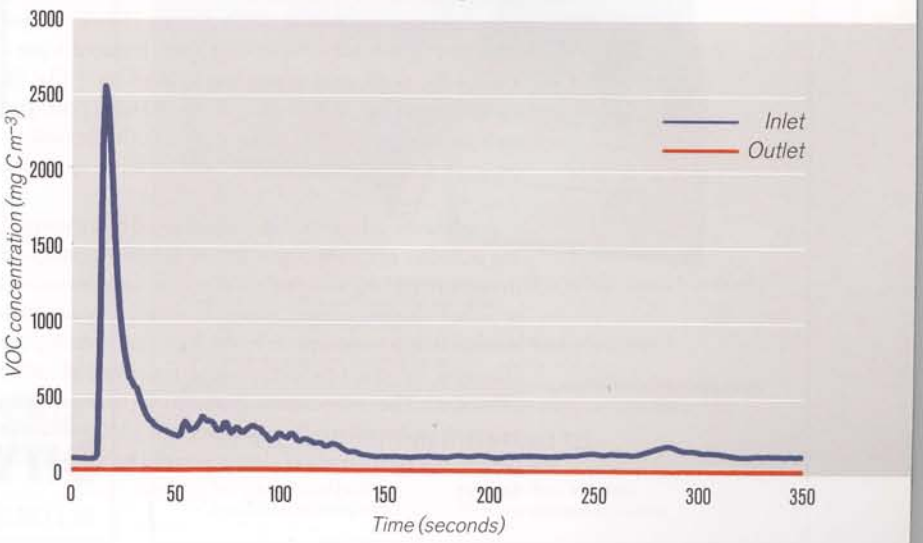


Fig. 4. VOC removal during ethyl acetate peak load



demonstration unit, an 8 m^3 demonstration system was constructed and commissioned. The unit was built at the R. Griggs and Company Ltd site at Wellingborough, manufacturers of the well-known 'Dr Martens' brand of footwear. The system (Fig. 2) was commissioned to treat between 200 and 900 m^3 off-gases h^{-1} containing methyl ethyl ketone, toluene and acetone. A skid-mounted pilot plant was sited on a 12 m^2 area adjacent to the factory. Engineering support for the construction of the unit was undertaken by Camfil Ltd, based on Viridian's design.

BELOW:
Fig. 5. A full-scale BIOVOX® system at R. Griggs and Company Ltd, Wellingborough.
COURTESY VIRIDIAN EHC LTD

The VOC concentrations of the inlet and outlet of the BIOVOX® demonstration unit were monitored using flame ionization detection (FID). Over a 168-day period the outlet concentration of VOC was reduced from a level of 300 mg C m^{-3} to less than 50 mg C m^{-3} (Fig. 3). Furthermore, the system was challenged with peak load tests and spikes of other solvents to test the flexibility, capacity and capability of this biotreatment approach (Fig. 4).

A weakness of bioprocesses, as perceived by industry, is the inability of micro-organisms to handle fluctuations in carbon loading and potential 'spike' concentrations of other solvent types, many of which occur when manufacturing operations in the footwear industry are changed for the production and finishing of other products. The consortium was found to be highly tolerant in handling fluctuations and changes to the nature of the solvents as demonstrated by the on-site facility.

Commercial realization

As a consequence of the successful demonstration of the VOC abatement technology, a full-scale BIOVOX® system was commissioned at the site treating a flow rate of over 16,000 m^3 solvent laden air h^{-1} at an average concentration and range of 200–300 mg C m^{-3} (Fig. 5). A 30% saving on capital costs and an overall 60% saving on operating costs, added to the successful demonstration has made the technology very cost-effective. The system is now attracting considerable attention from a number of commercial sectors using solvents, including the printing, painting, furniture and laminating industries. Further pilot-scale units have been tested and Viridian are building a number of full-scale units. Environmental biotechnology and the BIOVOX® approach are now offering industry new, robust, engineering solutions to tackle air pollution issues.

There is limited value in enhancing the rates of microbially mediated reactions if the overall bioprocess is controlled by physical issues. Clearly, detailed consideration of microbial physiology by process engineers is essential and it is only by truly integrating the wide expertise of other relevant disciplines that workable, commercially viable environmental biotechnological strategies and processes will succeed. Progress in the microbial sciences *sensu stricto* is not necessarily what is needed to exploit the new opportunities that are being presented by changes in the legislative regulatory framework: a cross-discipline approach merging traditional engineering with microbiology and economics seems to be the way to go.

● *Dr Ajay Sharman is Technical Director of Viridian EHC Ltd, 114–116 John Wilson Business Park, Thanet Way, Whitstable, Kent CT5 3QT*
Tel. 01227 770505; Fax 01227 770123
e-mail a-sharman@ibs-viridian.co.uk
● *Dr Cliff Burton is Managing Director of Viridian EHC Ltd*
e-mail c-burton@ibs-viridian.co.uk

Some threats and opportunities for learned societies in the new millennium

Ron Fraser

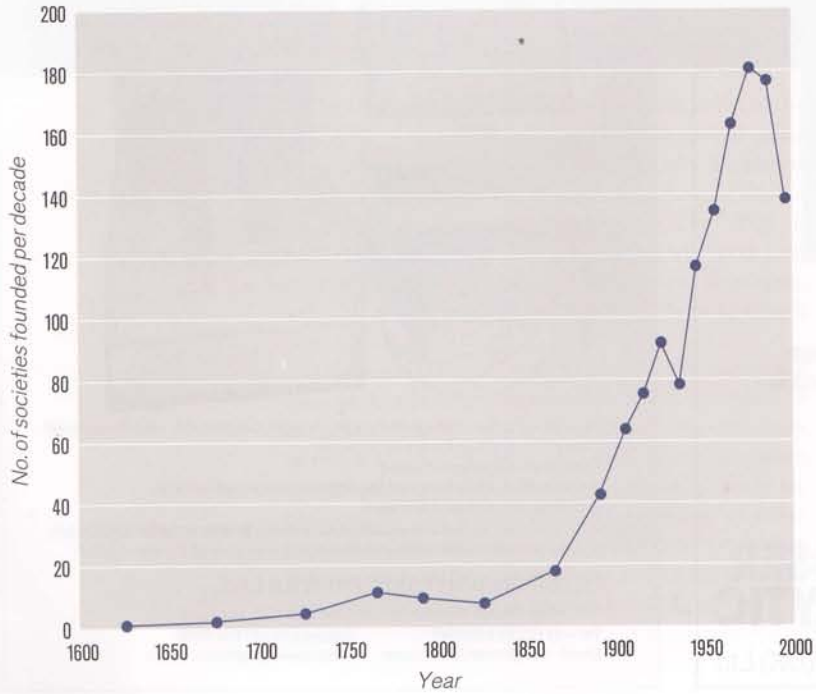
Microbiologists will always be needed, but what lies ahead for the professional bodies that represent them?

Although the oldest scientific learned societies can be traced back to the middle of the 17th century, most of the major UK learned societies in the biological sciences were founded in the late 19th century or the first half of the 20th century. This was part of a worldwide expansion of learned and professional societies in general (see Fig. 1), although the rate of formation seems to have dropped off in the last three decades. What of the future? New societies will continue to form, to cater for emerging branches of the science, or special interest groups, but these might also be interpreted as failure of the established societies to evolve appropriately.

Service to members and the science will be the key to continued support. Most learned societies were founded primarily to hold scientific meetings and provide an opportunity for members to network – although they would not have used the word in those days. Increasingly, we need to look at the total quality of our meetings, not just the science. This remains paramount, but the standards of facilities and other services provided are also important. Meetings have to be enjoyable as well as informative. Cheap air travel has made it possible to invite the best speakers from overseas, but has also made it easier to attend meetings overseas. The competition on quality and content will be increasingly global – until CO_2 emissions are at last taken seriously. Then perhaps the cyberconference will reign supreme.

Fig. 1. Foundation of learned and and professional societies

The data refer to learned and professional societies of all types, which are still active, and were derived from information published by the University of Waterloo Scholarly Societies Project http://www.lib.uwaterloo.ca/society/



Many learned societies have relied in the past on surpluses from their publications as a major component of their income, to support their charitable objectives. The advent of online publication has brought additional costs, and threats, to the traditional type of subscription income. The story is still unfolding: scientific publishing is experiencing the biggest revolution since Gutenberg. The logic of the Web is to maximize access and linkage, but these benefits carry implicit threats to our current business models and academic procedures. Powerful voices are arguing that the interests of authors and readers are best served if access to content is free. Those publishers who already derive a substantial proportion of their income from page charges, such as many of the US learned societies, are already half way to a model where authors are charged fees for peer review, editing and technical preparation of articles for free-access publication. This would have to be matched – as it has in the US – by a transfer of budgets from libraries to research grants.

The threat to peer review and journal brand identity posed by proposals such as *PubMed Central* should become clearer in the first few years of the new millennium. There is resistance to the idea of loosening quality controls, but movement may be technology-driven, leading to new paradigms for quality assessment. The current perceived ranking of journals provides a convenient if somewhat crude stratification of quality by which papers are judged. The incredibly detailed information available for online journals about which individual articles are being accessed and cited already offers a more sophisticated way of assessing and indeed managing impact.

Learned societies are of value to society because they are different. They are able to make a contribution to intellectual and material well being because they are independent of government, research councils, universities, etc., relatively unconstrained and able to target their activities for maximum effectiveness and added value. It is ironic that the 20th century, which has seen so many benefits from scientific progress, should end with the emergence of a virulent culture of 'antiscience', where the arguments are often expressed more in terms of narrow fanaticism than balanced logic. The learned societies, individually and in co-operation, must increase their activities in support of education and public understanding, to help allay this distrust.

For the learned societies in general, the new millennium will also see continued evolution of some well-established trends. It is unlikely that members in the universities, research institutes and elsewhere will see any decrease in the load posed by audit procedures such as research assessment exercises, teaching quality assurance, benchmarking and continuing professional development, on top of the core activities of their jobs. They must be able to protect the most important

MicroShorts

things they bring to society activities, in determining policy and in professional and scientific affairs. In doing this, they will need increasing executive support. This is not a serious problem for the large, well-founded societies, but may be difficult for smaller societies without large financial reserves, which still rely on members for administrative inputs.

Finally, there will be changes in the ways in which the societies operate as registered charities, and for those that are, limited companies. The Charity Commission is increasingly concerned with how charities achieve their objectives and utilize their resources, and the new Companies Act, due in 2002, will no doubt bring further changes.

The outlook is busy!

● *Ron Fraser, Executive Secretary*

This article is based on a paper given at a seminar, 'The Future of Learned and Professional Societies', organized by the Foundation for Science and Technology and the Association of Learned and Professional Society Publishers, and includes points made by some of the other speakers.

Funding

More JIF awards

The second tranche of awards from the Joint Infrastructure Fund, bankrolled by a partnership between the UK government and biomedical charity the Wellcome Trust, has been announced. Almost £320 million of new investment will be made to upgrade or provide new research facilities in universities. 45 projects in 27 institutions will be funded. The remainder of the available funds will be allocated in the final three rounds of bids which close in 2000.

European research funding

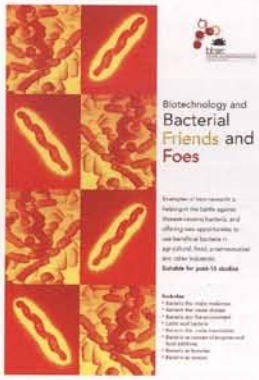
The Framework Programme Five (FP5), giving full details of research areas open to biotechnology and life science organizations, is now available. 15 billion euros is on offer to fund research, clinical and field trials. The following research areas are open for collaborative research proposal submissions in March: new therapeutic substances; *in vitro* testing as an alternative to animal testing; bioprocesses to improve industrial efficiency; innovative bioremediation and biodegradation technology; high-value products/ processes derived from microbes, plants and animals; functional biomolecules.

Gene flow in plants and micro-organisms

BBSRC and NERC have launched a new scheme to fund research on aspects of the impact of GM crops and micro-organisms, including potential benefits, with particular emphasis on optimizing the process of DNA insertion and understanding the consequences of gene flow. The closing date for applications is **15 May 2000**. Full details of the initiative and application forms are available on the BBSRC website: **www.bbsrc.ac.uk**

Education

Biotechnology and bacterial friends and foes



Recently issued by the BBSRC, this 16-page booklet for post-16 students gives examples of how research is helping in the battle against disease-causing bacteria and offering new opportunities to use beneficial bacteria in agricultural, food and pharmaceutical industries. It also covers the diverse roles of bacteria in the environment. Illustrated with colour photographs, single copies are free from BBSRC, Polaris House, North Star Avenue, Swindon SN2 1UH (www.bbsrc.ac.uk).

Classifying microbes

A large and colourful poster showing examples of the main groups of micro-organisms – bacteria, archaebacteria, protozoa, algae, fungi and viruses – has been produced by PCET Wallcharts. Aimed at post-16 biology students, it is also suitable for use with Key Stages 3 and 4 as an introduction to the diverse nature of microbes. The key features of each group are highlighted and the poster is accompanied by a set of more detailed teacher's notes with references and a glossary. SGM and MISAC acted as advisers to the publishers. The poster costs £7·75 + VAT from Pictorial Charts Educational Trust, 27 Kirchen Rd, London W13 0UD (Tel. 020 8567 5343; e-mail info@pcet.co.uk).

Communications

Life Sciences Directory online

Portland Press have released the Life Science Directory, containing the membership lists of the Biochemical Society, British Society for Immunology, Genetical Society, Medical Research Society and Society for Endocrinology online at **www.lifescientists.org** The Directory is searchable by name or address field. It contains 14,000 entries, with details of the name, address, telephone, fax, e-mail and society membership of each person. The Directory also contains an online products and services section, indexed by subject and company name.

FEMS 2000

FEMS celebrated its 25th birthday in November 1999. To mark the event, a range of new activities has been planned and the logo redesigned. The new FEMS website offers up-to-date information on all activities of the Federation and will host web pages for member societies. Check out the changes on **www.fems-microbiology.org**

CTI Biology Factsheets

Various aspects of computer-assisted learning and teaching are explained in detail in the CTI Biology handouts. Recent issues include: Computer-assisted assessment (using computers to design and deliver objective tests); Computer-mediated communication (creating an online discussion environment to support student learning); and Simulation in biology teaching (helping students understand dynamic systems in the real world using software such as Bacterial Growth 3, Bioquest, etc.). See **www.liv.ac.uk/ctibiol.html** for further information.

Safe transport of micro-organisms

Brian Mahy and John Mackenzie have prepared a report for the International Union of Microbiological Societies (IUMS) on *Transportation of Biological Materials*. They have surveyed recent documentation and regulations and conclude that the microbiological community should maintain constant vigilance to ensure that unnecessary restrictions are not imposed. *Guidelines for the Safe Transport of Infectious Substance and Diagnostic Specimens* (published by the WHO in 1997) provides a firm basis for future requirements of microbiologists, including those involved in the preservation and maintenance of culture collections.

Pharmaceutical giants

Several company mergers have taken place recently which could have a knock-on effect for the career prospects of microbiologists. Glaxo Wellcome and SmithKline Beecham will join to form the world's largest pharmaceutical company, with 7·3 % of the global drugs market. The new company, to be called Glaxo SmithKline, will be based in the UK but run from the States. Hoeschst of Germany has merged with Rhone Poulenc of France to form Aventis and AstraZeneca and Novartis are spinning off their agrochemicals division to form Syngenta. Pfizer is negotiating to take over Warner-Lambert and Monsanto is changing its name. Several biotechnological companies are also regrouping.

Trawling the horizontal gene pool

Christopher M. Thomas & Kornelia Smalla

Mobile genetic elements fuel bacterial response to environmental stress. Co-ordinated action is needed to define their importance in biosafety issues as well as to tap their potential as sources of new properties for biotechnology.

Bacteria are the most numerous organisms on this planet and have a vital rôle in buffering the biosphere against radical changes, not least those inflicted by man. Mobile genetic elements (MGE) endow their bacterial host with genetic variability and flexibility, promoting DNA rearrangements within a bacterium as well as exchange between bacteria. They thus fuel the bacterial response to environmental stress. Horizontal gene exchange provides an opportunity for the MGE and the genes it carries to out-replicate its original host by creating phenotypic combinations that are better adapted to the current environment or which can invade new ecological niches. MGEs provide a location where catabolic and anabolic genes can be assembled to provide the response to environmental stresses. The traits specified by mobile elements include resistance to antibiotics, heavy metals and radiation, biodegradation of xenobiotic compounds, symbiotic and virulence determinants, bacteriocin production and increased mutation frequencies. Despite the importance of MGEs, our present knowledge is extremely limited due in part to the non-culturability of the vast majority of bacteria in the environment, but also to the fact that most work on bacterial genetics has concentrated on just a few groups of species. Indeed studies on mobile elements have often focused on bacteria from clinical specimens. A better understanding of the diversity, maintenance and transfer functions of MGE and the acquisition and spread of new phenotypic traits will be only achieved by combining the expertise of molecular biologists and ecologists. EU funding through a Concerted Action entitled 'Mobile Genetic Elements' Contribution to Bacterial Adaptability and Diversity' (MECBAD) has provided a further opportunity to bring these two disciplines together.

Diversity and distribution of mobile genetic elements

A major objective of MECBAD is to develop the tools to assess whether there are many classes of completely unknown MGEs yet to be discovered and how the known MGEs are distributed. Most people are familiar with 'endogenous' plasmid isolation in which bacteria are cultured and plasmid DNA is extracted by standard techniques. To access MGEs in bacteria which are not culturable, 'exogenous' isolation mixes a marked host with environmental samples and determines whether it can capture MGEs carrying certain selectable traits. Exogenous isolation has been successful in capturing resistance and biodegradative plasmids. Experiences of different laboratories indicate that endogenous and exogenous isolation procedures yield completely different sets of plasmids, so both methods should be used in tandem. So far, exogenous isolation has only been successful with Gram-negative bacteria and then only with a limited range of species. Perhaps more appropriate recipients, and revised methodologies, will be important for success with Gram-positive bacteria.

The most vital part of a plasmid is the DNA that gives it the ability to replicate autonomously – the replicon. Plasmids are commonly defined by the replicon family to which they belong. Similarly, transposable elements are defined by their transposition functions. The commonly used set of replicon probes has been unsuccessful in identifying the vast majority of plasmids in natural environments. Therefore, we need strategies to identify the replicons and transfer systems from a wide range of plasmids in new environments. A possible approach for this may be through sequencing of complete plasmids. Funding will be required to sequence large numbers of plasmids and therefore an important task for the MECBAD group is to convince funding bodies and industry of the enormous contribution of MGE to bacterial diversity and the potential for biotechnology. Furthermore, the development of membranes or preferably biochips with a bank of *rep* probes should provide an important tool for environmental analysis.

Currently however, the most important tools being developed are the PCR primer systems for plasmid replicon, transfer and maintenance genes (Fig. 1). New primer sets for replicon families, as well as transposons and integrons, are absolutely essential if studies of the environmental prevalence of particular plasmid/replicon families are to be made. The development and testing of new primer sets is essential prior to studies of MGE prevalence in any complex environment. Since each new environment studied is likely to contain MGE systems unrelated to those for which sequence information is available, PCR-based methods must be used as part of a multiphasic approach together with exogenous and endogenous isolation.

Maintenance of MGEs

A key property of an MGE is the range of hosts in which it can establish itself and maintain itself stably. MGEs can be maintained in a bacterium either through autonomous replication as a plasmid or by integration into a genome that is capable of replication. A particular MGE may be able to exploit both strategies under different circumstances. For example, IncP-1α plasmids normally replicate autonomously, but in *Xanthomonas* species they integrate into the chromosome. Conversely, the IncJ elements of *Escherichia coli* normally integrate into the chromosome but if deprived of their normal integration machinery they are capable of autonomous replication. Novel elements are still being discovered, such as a catabolic transposon which appears capable of conjugative transfer followed by integration/excision by a site-specific process (either into a plasmid or a transposon), so fitting into a gap between temperate phage and conjugative transposon. Once present in a new host, the maintenance of an MGE can be regarded as the

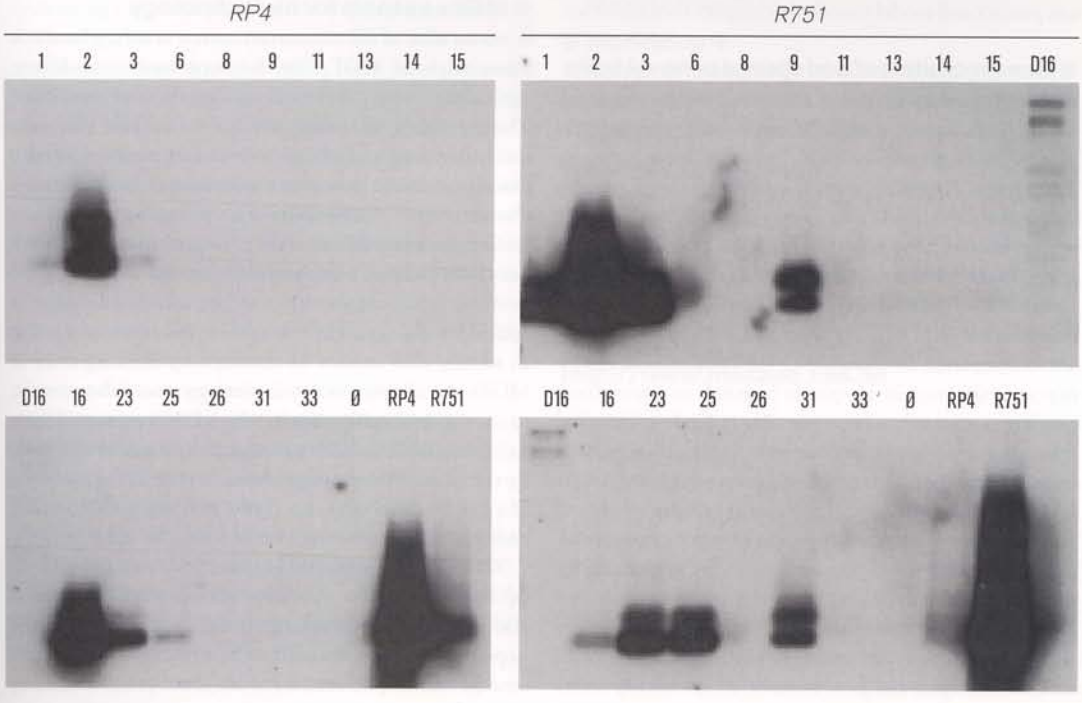
combination of stability of the MGE in its new host and the fitness of the host with the MGE in relation to bacteria without the MGE. Many observations of plasmid instability may reflect poor experimental design where we do not consider the true growth rate of the host under natural conditions (competition, nutrient, pH, temperature, etc.). Temperature is an extremely important environmental factor for the host range and stability of different plasmids, while benefits of plasmid carriage during stress or starvation should also not be ignored. A major focus is therefore to increase our understanding of how plasmids maintain themselves in populations and microbial communities, and particularly to extend what we know about plasmid maintenance in laboratory shake flasks and agar plates, to microcosms and real environments.

To determine host range it is important that a wide spectrum of hosts is used. Release of bacteria into complex communities followed by isolation of bacteria into which the plasmid has transferred may provide a means of looking at effective host range. However, studies on transfers to different host organisms are biased due to the lack of tools for including non-culturable or not-yet-cultured bacteria in the analysis. The use of plasmids tagged with fluorescent reporter genes (*gfp*) which are completely repressed in the donor strain but will become derepressed after transfer, will allow transconjugants to be detected without culturing (Fig. 2). The new host could then be identified by the use of host-specific oligofluors. However, *gfp* may not be expressed or functional in all hosts, thus limiting the range of recipients that will be detected. Another strategy may be to use antibody-based magnetic isolation of bacteria expressing plasmid-encoded surface antigens such as pilin, or surface exclusion protein, followed by a technique such as Denaturing Gradient Gel Electrophoresis (DGGE) on amplified rRNA to assess the diversity of host species. Flow cytometry could also be used to enrich for such transconjugants prior to identification. The sensitivity and selectivity of these techniques must be explored and developed.

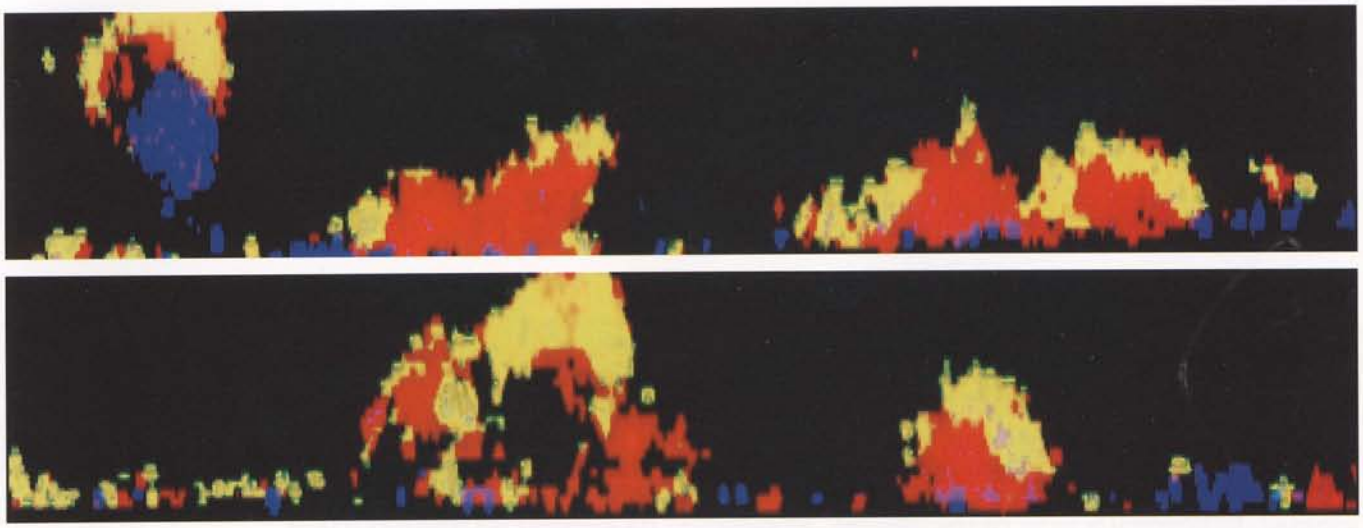
Transfer of MGEs

Conjugation is the transfer mechanism most usually associated with mobile elements but we still know surprisingly little about the process itself. For example, what triggers transfer? Is it the contact between a donor and recipient cell? How is the pore formed? How is the DNA transferred? Recent experiments have defined the pilus assembly machinery, but it has not yet been possible to uncouple DNA transport from pilus assembly. Perhaps the two processes are intimately coupled and therefore it will be valuable to continue comparing conjugative DNA transfer mechanisms with the development in our understanding of macromolecular transport in related processes, such as type II and type III protein export, and in processes of DNA transmission connected with competence as well as phage entry and extrusion. It is also pertinent to investigate the specificity of interactions between donors and recipients, since we know little about what controls the interaction between bacteria of different genera.

There is a need to study the signals that regulate expression of conjugative systems. Thus stress response,



LEFT:
Fig. 1. PCR-based detection of IncPα and IncPβ plasmids in total community DNA. Hybridization was with a *trfA2*-derived probe from RP4 (left) and R751 (right). Lanes: 1, potato rhizosphere; 2, degrading consortium from soil; 3, salt marsh; 6, mouse gut; 8, soil; 9, contaminated soil; 11, oil seed rape rhizosphere; 13, chicken manure; 14, cattle manure; 15, pig manure; 16, compost; 23, sewage; 25, copper-treated soil; 26, untreated rhizosphere; 31, fish farm sediment; 33, farm soil.
COURTESY KORNELIA SMALLA, BIOLOGISCHE BUNDESANSTALT FÜR LAND- UND FORSTWIRTSCHAFT, BRAUNSCHWEIG, GERMANY



ABOVE:
Fig. 2. Two vertical cross sections through a benzyl-alcohol-degrading biofilm, illustrating the spatial distribution of green fluorescent transconjugants (green/yellow) relative to the non-infected *Pseudomonas putida* cells (potential recipients) (red) and *Acinetobacter* strain C6 (blue). The biofilm was analysed 8 days after introduction of donor cells. *P. putida* (red) cells were identified by 16S rRNA hybridization. After hybridization, green fluorescent transconjugants appear as either yellow or green, depending on the ratio between the green GFP signal and the red hybridization signal.
COURTESY SØREN MOLIN, BJARKE CHRISTENSEN AND CLAUS STERNBERG, TECHNICAL UNIVERSITY OF DENMARK, LYNGBY, DENMARK

quorum sensing and diffusible factors, as well as the physiological state of donors and recipients will be researched in the future. These studies are vital to establish what types of conditions, compounds or signals stimulate plasmid transfers – the ecological aspects of plasmid transfer. This may allow us to explain why, for example, transfer of plasmid RP1 can occur between 100-day starved *Vibrio* cells in sea water, but not between *E. coli* strains. This suggests that the host/plasmid combination is a crucial determinant of transfer rate: *Vibrio* cells must have an energy maintenance mechanism that allows successful transfers to occur long after blocking of the energy sources. On the other hand, for biofilms composed of copiotrophic organisms such as pseudomonads, transfers of the TOL plasmid are confined to the outer (upper) biofilm regions, with presumably the highest metabolic activity (Fig. 2). This indicates the importance of cellular metabolic rate for successful transfers between copiotrophs, an inference previously made from studies in the rhizosphere, rhizoplane and in soil. The contrasting results between transfers between *Vibrio* spp. and those between copiotrophs likely relates to the ecophysiological host type. There is a clear need for future comparative research in this area so that we can predict and model transfer in complex communities.

Gene recruitment and spread of novel traits

The evolutionary spread of antibiotic resistance genes in the last 50 years cannot be described in traditional phylogenetical terms which deal with an accuracy of $\pm 10^6$ years. Therefore, other methods have been used to monitor the evolution and spread of such adaptive traits within bacteria. For example, it is clear from the data on glycopeptide resistance and the *vanA* gene that some estimate for gene mobility could be made. By combining information on the usage of certain growth-promoting antibiotics with data analysing the problems of vancomycin resistance in hospitals (arising in enterococci causing sepsis) it has been possible to find an identical resistance gene in two populations physically separated from one another. This case involved a series of stepwise transfers from hosts with overlapping environments to enable mobility from the farm environment to the hospital.

Studies of bacterial populations in rapidly changing environments, simulated in model systems such as a chemostat, have demonstrated that bacteria evolve rapidly where growth rates are relatively high (in comparison to soil, for example) and gene transfer occurs readily under selection of an adaptive trait. Genetic exchange increases potential for diversity and phenotypic plasticity. Gene mosaics have been discovered in several drug resistance genes where extensive chromosomal recombination has been mediated by transformation in Gram-positive pathogenic cocci. Much more difficult to evaluate is the rate at which genes are recruited on to mobile elements, such as plasmids, phages and transposons, facilitating transfers. A highly selective environment was made by the widespread use of antibiotics for growth promotion in farm animals and for use in human and veterinary medicine. A brief analysis of the resistance gene dissemination proves that horizontal gene transfer is highly efficient and an effective method for bacteria to acquire advantageous genes. Even when selection is removed, genes tend to remain associated with mobile elements: for example, mercury resistance on R-plasmids. However, caution is necessary to avoid over-simplification of environmental conditions: mercury is no longer used in hospitals as a disinfectant but it is ubiquitous, albeit at low levels, in most environments. Further work is needed to identify the reasons for persistence and spread of MGEs.

MGEs as tools for biotechnology

A major aim of the concerted action is to see how our knowledge of MGEs can be exploited in industry, agriculture, environmental management or medicine. The metabolic pathways carried on mobile elements are important and there is probably more diversity among catabolic genes than we know so far in the well characterized *Pseudomonaceae*. Exogenous plasmid isolation is a possible strategy. Using recipients that lack only one gene of a pathway allows the missing gene from environmental samples to be picked up by genetic complementation. However, there may be many genes in nature that cannot be accessed by looking only at MGEs. An alternative to this strategy would therefore be to use expression libraries in which DNA extracted from soil is cloned downstream of an active promoter, followed by the identification of genes which confer degradation of a given compound in a functional assay. Sequencing projects will also be useful in the search for novel genes.

The search for exploitable genes is purpose driven, e.g. for bioremediation. Chemostats (elegant but messy) allow one to put everything into the melting pot in the hope that a single strain or a consortium of strains will emerge. Since polluted sites are often simultaneously

contaminated with xenobiotic compounds and heavy metals, bioremediation needs strains that can detoxify both. Such strains have been constructed and shown to work under laboratory conditions. Since numerous aromatic compounds occur in nature it seems likely that most desirable pathways could be derived by mutation or rearrangement of genes of natural origin. Interestingly, where this has been observed already, plasmids of the IncP-1 group are associated with the rapid evolution step. A strategy to develop new biodegradative capacity would be to apply very strong selective pressure as in a grossly contaminated site. A promiscuous conjugative MGE, such as an IncP-1 plasmid, could be added to enhance the spread of genes in the bacterial community and to 'seed' the catabolic genes. This should achieve efficient detoxification of xenobiotic compounds by forced evolution of natural bacterial consortia using ideas derived from studies of the MGEs associated with natural evolution.

An issue relevant to our knowledge is the agricultural use of genetically modified organisms. While GM crops are widely accepted in the US, the situation in Europe is different: public opinion is strongly against their use. By contrast, GM vaccines against viruses such as hepatitis B or rabies are widely accepted. Hence, it seems that the public has a completely different perception of medically applied technology compared with that used in agriculture. In the same way, a modified bacterium capable of biodegrading gunpowder or land mines, if such a thing were invented, is likely to be acceptable because it is doing a useful job. It adds up to a risk versus benefit situation. With our food 'mountains', it is hardly surprising that people in developed countries do not see a need for this technology in food production and so do not want it. Following this argument there should be a future for *in situ* bioremediation with GMOs, but a good campaign will be necessary to inform the public of the benefits. On the other hand, if natural bacteria or bacterial consortia can be encouraged to evolve their capacity for bioremediation without *in vitro* recombination then the public perception of that would be much better. There is thus great scope for the exploitation of knowledge about MGEs and the natural recombination they can promote.

The authors would like to acknowledge the help of Drs Eva Top, Erich Lanka, Dick van Elsas and Elizabeth Wellington in preparing the report on which this article is based.

● *Kornelia Smalla is a group leader at Federal Biological Research Centre BBA, D38105 Braunschweig, Germany*
Fax +49 531 2993013; e-mail k.smalla@bba.de
● *Christopher Thomas is Professor of Molecular Genetics in the School of Biosciences, University of Birmingham, Edgbaston, Birmingham B15 2TT*
Tel. 0121 414 5903; Fax 0121 414 5925
e-mail c.m.thomas@bham.ac.uk

MECBAD involves 44 research groups from 12 countries across Europe. The groups already have an established tradition of working together since they were previously funded for 3 years (1994–1997) by an ESF Network to study 'The Molecular Biology and Ecology of Plasmid-Mediated Gene Spread'.

MECBAD started in October 1998 and is due to run to September 2000. The main activities are listed below.

- **First Symposium**
  Strasbourg – April 1999
- **Workshop 1**
  Prevalence of mobile genetic elements
  Braunschweig – June 1999
- **Workshop 2**
  Characterisation of new mobile elements
  Birmingham – March 2000
- **Workshop 3**
  Conjugation systems viewed as protein secretion pathways
  Munich – May 2000
- **Workshop 4**
  New tools to study microbial physiology and plasmid transfer
  Copenhagen – August 2000
- **Second Symposium**
  Prague – September 2000

If you would like to know more about **MECBAD** or apply to attend any of the remaining activities, please contact the Chairman, Kornelia Smalla, at **k.smalla@bba.de** or visit our website at **http://www.mecbad.bba.de**

The Millennium for Microbiology

2000 Joint Scientific Meeting
8–13 July 2000
Cairns, Queensland, Australia

For further information, contact:
The ASM Secretariat, Unit 23,
20 Commercial Road, Melbourne,
Vic 3004, Australia
Tel. +61 3 9867 8699
Fax +61 3 9867 8722
e-mail admin@theasm.com.au
www.vicnet.net.au/~asm

As we enter the first century of the next millennium, the general public is being made more aware that human society will be as dependent as much on microbiology and applications of biotechnology to microbiology as it will be dependent on computers and information technology. This is the theme of the 2000 Joint Scientific Meeting being held by The Australian Society for Microbiology at the Cairns Convention Centre in Tropical North Queensland in July 2000.

A stimulating, informative and diverse scientific program, based on the theme *The Millennium for Microbiology* covering many topical issues relating to various microbiological disciplines has been devised by the Organizing Committee.

A warm invitation is extended to all microbiologists to attend the last ASM Meeting of the Millennium.

Report from the year 2025 meeting of the American Microbiological Society: *Discovery of the bacterial 'taxonomy gene'*

Howard Gest

The following satire is based on Howard Gest's view that the evolutionary history of bacteria was more complex than commonly supposed and cannot be traced with accuracy using 16S rRNA sequences as the sole criterion. Indeed, during recent years, a number of reports summarizing new research findings, including evidence suggesting the widespread occurrence of lateral gene transfer, cast doubt on the validity of bacterial evolutionary phylogeny based on rRNA trees. Gest emphasizes that rRNA sequences will probably prove to be useful eventually for identifying certain kinds of taxonomic relationships, but will not serve to provide an unambiguous evolutionary phylogeny of bacteria. Accordingly, he argues that changing the names of numerous well-known genera and species on the basis of rRNA sequences is premature and counter-productive to formulation of a logical, scientific scheme of bacterial relationships and classification.

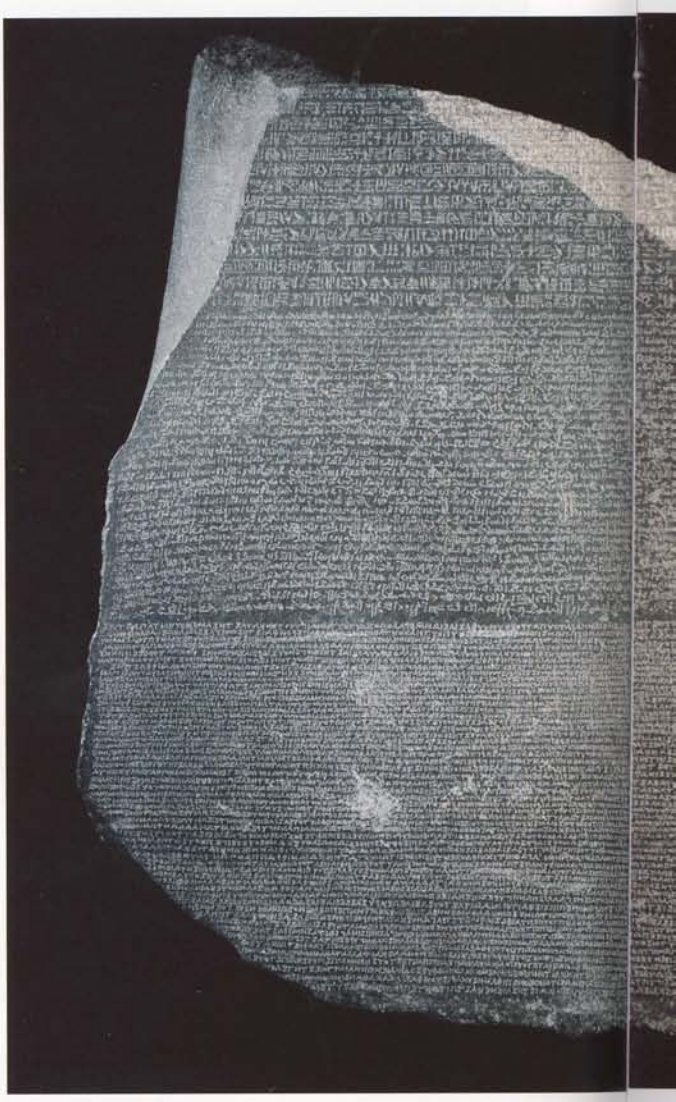
It is not widely known that while Sir Isaac Newton was developing his epoch-making work in mathematics and astronomy, he spent much effort and time on alchemical, esoteric, theological and mystical studies. John M. Keynes estimated that Newton left behind unpublished manuscripts of more than 1,000,000 words in a great box at Cambridge. According to Keynes, Newton looked on the whole universe *'as a riddle, as a secret which could be read by applying pure thought to certain evidence, certain mystical clues'*. Newton believed that these clues were *'partly in certain papers and traditions handed down by the brethren in an unbroken chain back to the original cryptic revelation in Babylonia'*. There is no doubt that through the ages, lesser minds than Newton's made similar unsuccessful attempts to unlock the secrets of life and the universe from ancient writings.

Etruscan promises

The Etruscan language has defied all attempts at translation. During the 1990s, a bronze sheet with Etruscan inscriptions dating from the late third to the early second century BC was discovered near Cortona (Italy) and this gave some promise for progress (*Italy Daily*, July 1, 1999). However, the limited text of only 27 previously unknown words proved to be a disappointment because it appeared to concern only a transaction of some sort between a few aristocratic families. Hopes soared in 2008 when a more detailed tablet was unearthed beneath the Basilica San Vitale near Ravenna. The 'San Vitale Slab' was inscribed in presumably parallel messages in Greek, Latin and Etruscan, and is now in the British Museum, next to the Rosetta Stone. Only part of the San Vitale Slab could be deciphered and surprisingly, this dealt with scientific matters. The Etruscan script gave the relative atomic weights of selenium, platinum, plutonium and seaborgium (element 106), and the value of π to 987 places. Of course, the excitement in academic circles was considerable, but further progress again slowed to a snail's pace. Nevertheless, the advance was a harbinger showing Newton's prescience in seeking explanations of natural phenomena in ancient records.

Concealed messages in DNA

The possibility that universal truths could have been deliberately concealed in 'DNA language' was bolstered on the eve of the present millennium by scientists who devised an encryption system based on genetic coding. The method developed by Clelland *et al.* utilized features of a procedure used by German spies during World War II to transmit secret information. In the spy system, the photograph of a typewritten page was greatly reduced to the size of a 'microdot' that could be pasted over an ordinary dot (i.e. a full stop) in a seemingly innocuous letter. The concealed message could easily be recovered by photographic enlargement.



Clelland *et al.* went many steps further by using a DNA-encoded message that could be camouflaged within the enormous complexity of human genomic DNA and then further concealed by confining the message within a microdot. The encryption key was simple. Letters of the English alphabet were assigned to nucleic acid base triplets. Thus letter *a* = CGA, *b* = CCA, *c* = GTT, etc. Primers were designed so that the base-encoded message in a polynucleotide could be selectively revealed using the PCR reaction directly on the microdots. The Clelland method was successfully demonstrated using 'DNA microdots' pasted on full stops (with common adhesives) in a printed letter sent through the US mail.

The DNA microdot method seemed to be foolproof, but puzzles based only on technological gimmicks obviously can be expected to be solved using even more advanced technological tricks. Thus in 2017, Valentin Miescher and his colleagues in Switzerland finally

discovered the functions of so-called junk DNA (and thereby the so-called Second Order Genetic Code) and this, together with ultra-sensitive scanning methods, quickly led to simple ways of locating and decoding the DNA microdots. It then became evident that construction of more sophisticated coding systems would require input of esoteric cultural information as well as advanced micro-technological innovations.

Maturation of the Glass Bead Game

After a lapse of some 250 years we now have evidence that Newton was on the right track in searching for explanations of natural phenomena in very ancient sources. Some success has finally been achieved as a consequence of development of the Glass Bead Game (GBG) invented in 1943 by Hermann Hesse (Nobel Laureate 1946).

The elaborate GBG was originally practised by a select monastic-like brotherhood. The game required high intelligence and great skill, and one could become a 'Magister' only after many years of training and trials. An early, primitive version of the GBG was in the form of musical exercises played on a frame holding several dozen wires on which could be strung glass beads of various sizes, shapes and colours. The wires corresponded to musical staffs and the beadsto time-values of the notes. With this device, a person could '*represent with beads musical quotations or invented themes, could alter, transpose, and develop them, change them and set them in counterpoint to one another*'. Within a few decades, the GBG was taken over by mathematicians, who modified it to a high degree of flexibility. Soon, the GBG was developed so that '*it was capable of expressing mathematical processes by special symbols and abbreviations. The players, mutually elaborating these processes, threw these abstract formulas at one another, displaying the sequences and possibilities of their science.*'

It was only a matter of time before the GBG was taken up and imitated by other scientific and scholarly disciplines. Eventually, the GBG could be regarded as a kind of language. According to the World Commission of the GBG, its archives contain the '*register of all hitherto examined and accepted symbols and decipherments, whose number long ago exceeded the number of the Chinese ideographs*'. With the discovery of the basic structure of DNA by Watson & Crick in 1953, it could be expected that 'DNA language', and thus 'protein language', would furnish a lexicon for variations of the GBG.

The first 'protein-language GBG' emerged in the 1990s. To compare patterns of amino acid sequences of various proteins, individual English letters had earlier been assigned to each of the ca 20 amino acids. Inevitably, someone posed the questions: do any English words occur in such sequences, and if there are English words, what is the longest one can find? Game players in certain organizations had the spare time, necessary computers and funds to play the game, informally known as 'protein talk'. In 1993, two Swiss scientists (Gonnett & Benner) matched the entire *Oxford Unabridged English Dictionary* (2nd edition; 20 volumes; 572,728,830 characters, with information content close to that of the human genome) against the entire SwissProt protein sequence database. They found two words with nine characters: *hidalgism* (the manner or practice of a hidalgo, a man of the lower nobility in Spain) and *ensilists* (plural of ensilist, one who protects his crops by ensilage). The game players concluded, '*In addition to being the longest strings appearing simultaneously in the English and protein languages, these are also candidates for the most unusable pieces of information simultaneously in lexicography and in biochemistry*'.

The protein talk report cited soon elicited a response from a British scientist (David Jones) who asked the sensible question, '*But what of other languages? Given that the ownership of the longest peptide-word* [i.e. protein-word] *will undoubtedly become a source of intense national pride, I thought it wise to investigate.*' So, Jones proceeded to search the SwissProt database with a multilingual word list of 1·3 million words from Danish, Dutch, English, Finnish, French, German, Italian, Norwegian, Swedish, Spanish and some Esperanto. Results: the nine-letter words: *ansvarlig* (Danish for 'liable'), *haletante* (French for 'breathless'), *salasivat* (the past tense of Finnish for 'to keep hidden' or 'to encode'), *saltsilda* (Norwegian for 'salted herring') and *stillassi* (the perfect subjunctive of the Italian word *stillare*, 'to drip'). The search also turned up one 10-letter Italian word, *annidavate* (past imperfect tense of *annidare*, 'to nest'). Jones asked, '*How long will we have to wait before Germany finally scoops the honours with the possible 27-letter peptide word for social sciences: Gesellschaftswissenschaften?*' Subsequent research (2000–2010) on large genes and proteins indicated that their sequences might well encode even longer messages intelligible in human language scripts.

LEFT:
The Rosetta Stone
PHOTO COURTESY THE BRITISH MUSEUM

Further reading

Clelland, C.T., Risca, V. & Bancroft, C. (1999). Hiding messages in DNA microdots. *Nature* 399, 533–534.

Crick, F. (1981). *Life Itself – Its Origin and Nature*. New York: Simon & Schuster.

Gest, H. (1999). Bacterial classification and taxonomy: a 'primer' for the new millennium. *Microbiology Today* 26, 70–72.

Gonnet, G.H. & Benner, S.A. (1993). A word in your protein. *Nature* 361, 121.

Hesse, H. (1970). *Magister Ludi – The Glass Bead Game* (English translation). New York, Toronto, London: Bantam Books.

Jones, D. (1993). More protein talk. *Nature* 361, 694.

Keynes, J.M. (1956). In *Essays and Sketches in Biography*, pp. 280–290. New York: Meridian Books.

Needham, J. (1954–1988). *Science and Civilisation in China*. Cambridge: Cambridge University Press.

By 2015, the GBG had a special language and set of rules for every discipline and subdiscipline, and so a wide variety of derivative GBGs evolved. The further development of computers greatly enhanced biological variations of the GBG. But a major problem in solving puzzles persisted, namely identification of the human language in which ancient sages could have encoded particular 'Secrets of Life'. Even with supercomputers, it would require vast knowledge of human history and culture and decades of trials to identify the languages in which explanations of biological phenomena were hidden in ancient writings.

Breakthrough in 2025

Fortunately, serendipity continues to play a significant rôle in scientific discovery. One member of a large team of scientific workers at NASA's PABLUM project (Planetary AstroBiological Launch for Unidentified Microbes) happens to be married to a Chinese history scholar who is familiar with the history of science and civilization in China (see Joseph Needham's monumental compilation). At her suggestion, the team, applying principles of the GBG, checked a rare Chinese dialect used by followers of Mencius (ca 371–289 BC), the so-called Second Sage, who was second only to Confucius, the Supreme Sage. As announced in the Abstracts of this year's meeting of the American Microbiological Society, this led to identification of the hitherto unknown 'taxonomy gene'.

When the base sequence of the taxonomy gene of a bacterium is transliterated into the Mencius dialect, and then transmogrified into English equivalents, the true name of the organism emerges. Thus, its evolutionary phylogeny is revealed and century-long controversies on the most relevant criteria for constructing taxonomic schemes are at an end. From now on, *Escherichia coli* will be designated *Proteofermentoformicus lipocylindricus*. Similarly, a majority of existing genera and species names will be changed by a reconstituted taxonomy committee responsible for the new *Bergey's Ultimate Manual of Definitive Bacteriology*.

How did the taxonomy gene originate?

Francis Crick's book *Life Itself* gives food for thought. Crick entertains the possibility that on some distant planet there *'evolved a form of higher creature who, like ourselves, had discovered science and technology, developing them far beyond anything we have accomplished...'*. Imagining various disaster scenarios, Crick suggests that these creatures would have planned to colonize other planets, and that they may have sent microbes to the Earth as an initial step. With his classic style of understatement, Crick says, *'The senders could well have developed wholly new strains of micro-organisms, specially designed to cope with prebiotic conditions, but whether it would have been better to try to combine all the desirable properties within one single type of organism or to send many different organisms is not completely clear'*.

It would not be surprising that a 'supercivilization' of the kind envisioned by Crick could have deliberately designed genes (for implantation into microbes) containing messages of importance for edification of the higher forms of life that would eventually evolve on Earth. Discovery of the bacterial taxonomy gene encoded in an obscure Chinese dialect lends further support to the increasingly popular view that representatives of very advanced civilizations visited Earth eons ago, and more recently from time to time.

● *Howard Gest is Distinguished Professor Emeritus at Indiana University, USA, where he works in the Photosynthetic Bacteria Group. He may be contacted at the Department of Biology, Jordan Hall, Indiana University, Bloomington, IN 47405, USA*
Tel. +1 812 855 9612
e-mail hgest@sunflower.bio.indiana.edu

Benchmarking the microbiologist – a new dawn for learning and teaching in life sciences?

Helen O'Sullivan

Academic standards are under scrutiny by the Quality Assurance Agency. Helen O'Sullivan explains the implications of benchmarking for microbiology teaching in higher education.

Given the fast pace of change in higher education, it seems inappropriate to talk about the dawning millennium heralding a new era in learning and teaching. However, the publication of the Dearing Report in 1997 crystallized an agenda that has led to the proposal of significant changes in the way that higher education is accountable to its funding body. Amongst those proposals, the idea of benchmarking has attracted considerable attention. As the Biosciences Benchmarking Panel begins its work in May 2000, it is timely to consider the likely impact of this proposal on the teaching of microbiology over the next few years.

Benchmarking and Dearing

When the National Committee of Inquiry into Higher Education published its findings in July 1997, tucked away in a section on qualifications and standards was a recommendation that the Quality Assurance Agency (QAA) should set up '*small expert teams to provide benchmark information on standards, in particular threshold standards, operating within the framework of qualifications, and completing the task by 2000*'. The committee made this recommendation because they considered that the current system of establishing and maintaining academic standards through the external examiner was no longer adequate in a continually expanding and diversifying system of higher education.

A new approach to quality assurance

In October 1998, the QAA set out the new quality assurance framework that will be adopted across the sector after its current audit programme comes to an end in 2001. Central to the new approach are the notions of:

Qualifications Framework – where all qualifications offered can be mapped on to a national framework, so ensuring consistency of titles and levels

Programme Specification – where institutions are required to set down the intended outcomes of each programme

Codes of Practice – specifying good practice in a number of areas relating to the support of student learning and maintenance of academic standards

Subject Benchmark Standards

The aim of a Subject Benchmark Standard is '*to set agreed national standards in each subject*'. During the consultation period for the new approach, many institutions raised practical and philosophical objections to this proposal. Fears were expressed that benchmarking would be overbearing and prescriptive and inevitably lead to a national curriculum for higher education. Alternatively, the benchmarks would be so general as to be practically useless. In addition, there were concerns about the ability of any group to set national requirements in subjects that are interdisciplinary or multidisciplinary. Institutions with specific mission statements were concerned that the ability to focus their provision to that mission would be lost. Modular structures, with the opportunity for students to combine subjects, take a major or minor route, study a general programme or become highly specialized also pose a significant challenge to the concept. However, the QAA concluded that support for the notion of benchmarking from employers and students was overwhelming and public concern that the transition to mass higher education had resulted in the lowering of standards must be addressed. QAA argued that subject benchmarking could potentially answer these concerns and fears.

Pilot studies

Pilot studies into the usefulness of subject benchmarks in assessing quality are underway. Three subjects were chosen to provide initial subject benchmarks: chemistry, history and law. The draft statements are published and are now being used in trials of the new quality assurance method (mainly in Scotland and Wales). Each group worked independently with a broad remit and therefore each statement is quite different. Most significantly, each group chose to define its benchmark level in a different way; one at a threshold level, one at the level likely to be attained by a typical student and the other at a level required for progression on to a professional qualification. Perhaps of most interest to microbiologists are the draft benchmark standards for chemistry. This document has four components:

- a statement of what the main aims of a degree programme in chemistry should be;

PHOTO SGM

- a statement of the subject knowledge with which all students should be conversant;
- a statement of the skills and abilities that students are expected to develop (these include chemistry-related cognitive skills and abilities, chemistry-related practical skills and transferable skills);
- a statement about the methods of assessment that should be used with defined performance criteria.

The draft statement suggests that the benchmark standards contained within it are applicable to all broadly based specialist programmes in chemistry as well as programmes in specialist applications of chemistry and those that have chemistry as a major component. However, it acknowledges that further work remains to be done to address joint honours and multidisciplinary programmes with chemistry components.

Whilst it might seem improbable that a group of academics could agree on a list of contents that should be covered by all students in a certain subject, this task is relatively easy compared with agreeing a common interpretation of the standards set. Commissioned by the Higher Education Quality Council (a forerunner of the QAA), Manz Yorke and co-workers studied the feasibility of benchmarking academic standards in three subject areas: history, computer studies and business studies. Seven post-1992 universities with modular curricula took part in the study. Modules were selected with broadly similar academic demands and were compared for similarities in a range of areas, including methods of delivery, assessment and profile of student achievement. The study report focuses on the equivalence of the standards expected of the students and the equivalence of the standards they actually achieved. Amongst extensive findings, the group showed evidence of variability in assessment demands as well as in students' achievement. The report suggests that it is a matter of debate as to whether this represents a variability in actual intellectual demand. In conclusion, the authors argue that the evidence of the study is sufficient to throw doubt on the viability of an approach that attempted to set standards through simplistic statements. The report suggests that it is through discussion and exemplification that these standards and criteria can become meaningful. Perhaps this can be compared to the practice of using assessment criteria in grading students' work. We all use criteria to reach a judgement but if we really felt that these criteria gave rise to a completely objective grading mechanism then none of us would bother with anonymous marking, second marking or moderation.

Benchmarking for microbiology?

How is microbiology to be affected by these developments? A Quality and Standards in Higher Education Biological Sciences Forum met in Autumn 1999 with a secretariat provided by The Institute of Biology. The Forum Group comprised representatives from Heads of University Biological Sciences departments (HUBS), UKLSC, UKNCM and other individual learned societies. This group consulted with QAA on what was required of the benchmarking panel and advertised via HUBS for members of the panel to be nominated or to self-nominate. The group is currently sifting those applications to produce the panel which will start work in May 2000. The panel has been charged with setting a subject benchmark standard for 'biosciences' – the designated standard subject unit. This panel will include representatives from all of the major subject groupings, and all types of higher education establishment within the bioscience category. They will produce a draft benchmarking document for comment by the bioscience community.

The challenges for this panel are enormous. This subject benchmark standard will need to apply to all programmes that fall into the specified category of bioscience. Can they apply to a range including general microbiology degrees, applied microbiology degrees or to programmes in such disparate areas as ecology, physiology, zoology, molecular genetics, plant science and biochemistry? Can they cover a range of general and applied biological sciences programmes across the sector and programmes where biology is a major or minor component studied with another subject? Within the current benchmarking framework, the answer to these questions has to be 'yes'. It may be that, due to the necessarily generic nature of biosciences benchmarking, we will be required to produce more subject-specific benchmarks in future. Some academics are already arguing that far from representing the prescriptive 'national curriculum' that was feared, the biosciences benchmarking process may have to be so broad as to have little impact on the way in which bioscience degrees are taught. The outcomes will only be seen when the benchmarking document is produced and in use.

There seems little doubt that such QA processes will continue to shape learning and teaching in microbiology for the opening years of the millennium. We all need to become involved in this process, to look for ways to make it workable and be brave enough to look for alternatives if it does not.

● *Dr Helen O'Sullivan has recently completed a term of office on the SGM Education Group Committee. She may be contacted at Environmental & Biological Sciences, Liverpool Hope University College, Hope Park, Liverpool L16 9JD*
Tel. 0151 291 3045; Fax 0151 291 3172
e-mail osullih@livhope.ac.uk

Further reading

NCIHE (1997). Higher education in the learning society. *Report of the National Committee of Inquiry into Higher Education*. London: HMSO.

QAA (1998). Quality assurance: a new approach. *Higher Quality* 4 (October).

QAA (1999). *Pilot Studies in Benchmarking Assessment Practice*. Quality Assurance Agency.

Yorke, M. & others (1999). Benchmarking academic standards in the UK. *Tertiary Education and Management* 5, 81–96.

SocietyNews

November Council Meeting

New Council Officers

● Professor Dalton informed Council that Professor Howard Jenkinson would take over as Scientific Meetings Officer at the Society AGM in September 2000. In the meantime he will shadow Dr Pat Goodwin. The search for two other vacancies which will fall vacant at the same time – President and Editor of *Microbiology Today* – was still in progress.

Strategy Working Party

● From time to time a small group of Council members and senior Headquarters Staff meet under the chairmanship of the President to consider how the Society's Charitable Aims can best be fulfilled in the light of the funding available. A number of recommendations were taken to Council, and the following were approved:

● President's Fund – commencing in January 2000, increased maximum limits will be available for awards. See p. 35 for details.

● Education Prize – an annual award will be made for excellence in microbiological education. Further details and a call for nominations will be announced in due course in *Microbiology Today*.

● Young Members – in recognition of the scientific needs of younger members of the Society, Council has agreed to set up a Working Party under the Chairmanship of Dr Liz Sockett, SGM Education Officer, to consider the possibilities of establishing a Young Members' Group. This would enable them to have greater input in the running of their own events and provide opportunities to present their work to each other. Young members with ideas about events which would be helpful to them should contact Dr Sockett (e-mail: liz.sockett@nottingham.ac.uk).

● Speaker allocation – the annual allocation of overseas speakers to the Groups would be increased as a means of maintaining the high quality of SGM meetings. This will take effect from 2001 as the programmes for 2000 are complete.

● External relations activities – in view of the extended range of activities to be carried out from Marlborough House, with particular respect to lobbying government and interactions with the media, it was agreed to appoint a full-time member of staff to carry out this rôle.

A number of other suggested initiatives will be considered.

Professional Affairs

● The Society has recently been involved in several consultations relevant to microbiology research and education. Professor Ritchie, the Professional Affairs Officer, had responded to the request for comments on the assessment criteria to be used for the 2001 Research Assessment Exercise that were relevant to microbiology. He also reported his input into various IoB initiatives. Dr Sockett had attended a forum for quality and standards on higher education in biological sciences on behalf of the Society. This body would be setting up a benchmarking panel for all biosciences degrees in the UK. See p. 31 for further information. Council's endorsement of the recommendations of the Strategy Working Party should ensure that SGM plays a full part in discussions on all such matters of policy in the future.

● *Alan Vivian, General Secretary*

Next President

Professor Sir David Hopwood, FRS, has accepted the invitation from Council to become the next President of the Society. Professor Hopwood recently retired from the John Innes Centre, Norwich, but he is still actively engaged in research. He will take up office in September at the SGM Annual General Meeting. A profile of Professor Hopwood will appear in the August issue of *Microbiology Today*.

Nominations for Members of Council

Three members of Council, **Dr G.B. Clements**, **Professor D.J. Rowlands** and **Dr E.M.H. Wellington**, retire from Council in September 2000. Another vacancy will also arise when **Professor C.M. Thomas**, who is an Ordinary Member of Council, becomes the Editor-in-Chief of *Microbiology*. Nominations are invited from Ordinary Members to fill these four 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 two years.

Nominations should be sent to the SGM General Secretary, Professor A. Vivian, Department of Biological & Biomedical Sciences, University of the West of England, Coldharbour Lane, Bristol BS16 1QY to arrive **no later than 27 April 2000**.

New Domain Name for SGM

The Society is pleased to announce that the naming committee of the United Kingdom Education and Research Networking Association (UKERNA) has accepted our request for the domain name **sgm.ac.uk**. Therefore from now on, this may be used in e-mailing staff at Marlborough House and when accessing the website:

http://www.sgm.ac.uk

The old domain *socgenmicrobiol.org.uk* will still work for mail and the web for the foreseeable future.

New Year Honours

Professor John E. Beringer, CBE, Dean of Faculty of Science, University of Bristol, lately chairman, Advisory Committee on Releases to the Environment, has been appointed a Knight for services to environmental safety.

Professor Patricia A. Nuttall, Director, Natural Environment Research Council, Institute of Virology and Environmental Microbiology, has been awarded an OBE for services to environmental sciences.

Professor John F. Peberdy, School of Biological Sciences, University of Nottingham, has been awarded an MBE for services to entrepreneurial training for scientists.

News of Members

Professor Jeffrey Almond has been appointed Senior Vice President of Research and Development, Aventis Pasteur. See p. 39 for new contact details.

Professor Tim Gray has taken up office as Chairman of the Bacteriology and Applied Microbiology Division of the International Union of Microbiological Societies.

Professor Allan Hamilton has become Treasurer of the International Union of Microbiological Societies.

Dr David J. Kelly, Department of Molecular Biology and Biotechnology, University of Sheffield, has been appointed to a personal chair in microbial physiology.

Dr Athanasios G. Papavassiliou MD PhD, Associate Professor of Biochemistry, University of Patras School of Medicine, Patras, Greece has been awarded the 1999 Academy of Sciences of Greece (Academy of Athens) Award for his innovative study on cancer treatment perspectives.

Professor Hans G. Trüper, Institut für Mikrobiologie & Biotechnologie, Universität Bonn, Germany (Editor IJSEM), and **Dr Wilhelm Frederiksen**, Rodding, Denmark, have been awarded the Bergey Medal for long-term distinguished achievement in bacterial taxonomy.

Grants

Watanabe Book Fund

A generous donation to the Society by Professor T. Watanabe of Japan has enabled the Society to set up a fund to make annual awards for the benefit of members in Developing Countries. This is distinct from our own International Development Fund.

Members of the Society who are permanently resident in a Developing Country may apply. The purpose of the fund is to enable members involved in higher education and/or research to acquire for their libraries books or possibly journals relating to microbiology. Applications should include:

1. A list of the publications required together with an estimate of their cost (the total cost for any one application should not exceed £300 sterling).

2. A letter from the Head Librarian of the organization certifying the need for the books and the address to which the books should be sent, a statement on where the books will be kept and an outline of the loan arrangements for members of the organization.

3. A description of the member's organization and its involvement in microbiology, the number of staff and students and details of the nature of any courses in microbiology provided by the organization, i.e. BSc Microbiology, technical training, etc.

4. A *curriculum vitae* of the principal applicant.

None of these items (1–4 inclusive) should exceed one side of A4 paper each.

The closing date for applications is **6 October 2000**. Applications (single copies) should be sent to the Grants Office at SGM HQ.

Awards 1999

Only two applications to the Fund were received in 1999. Awards of publications to the value of £300 each were made to **Ms T. Chaithong**, Maejo University, Thailand and **Dr T.R.C. Ndowora**, Kutsaga Research Station, Harare, Zimbabwe.

International Development Fund Award 1999

The following awards have been made from the Society's International Development Fund. The Fund exists to provide training courses, publications and other assistance to microbiologists in Developing Countries. The Rules for the 2000 Fund will be advertised in the May issue of *Microbiology Today*.

- **Dr S. Cutting**, School of Biological Sciences, Royal Holloway, University of London – up to £6,000 to run a workshop on molecular microbiology and its application to disease in Vietnam.
- **Dr P.N. Green**, NCIMB Ltd – up to £5,045 to run a culture collection management course in Cuba.
- **Dr I. Savvaidis**, Department of Microbiology, University of Ionnina, Greece – up to £4,000 to run a course on microbial ecology and biotechnology in Brazil.

A report on one of the 1998 International Development Fund awards appears on p. 53.

Details of all Society grant schemes are now available on the SGM website at **http://www.sgm.ac.uk**. You can also download the application forms for most schemes. Click on the Grants & Funding button for details.

Any enquiries should be made to the Grants Office, SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AE (Tel: 0118 988 1821; Fax: 0118 988 5656; e-mail: grants@sgm.ac.uk).

New Rules for the President's Fund

The President's Fund offers financial support to younger members of the Society for one of the following:

1. Travelling to present a paper or a poster on a microbiological topic at a scientific meeting.

2. Attending a short course (up to two weeks).

3. Making a short research visit.

At the recent Council meeting it was decided that President's Fund grants would be increased. The rules of the scheme have also been changed to allow for larger awards to be made for short research visits. There are now separate application forms for the latter. The new rules apply **from 1 January 2000**.

- 1 & 2 Smaller Awards

Maximum grants are now £125 for attendance at meetings or institutions/attending an approved course in the country of residence, £200 for travel to another European country and £300 for travel outside Europe.

- 3 Larger Awards

Up to £2,000 is available for making a short research visit of up to two months duration. The host institution may be overseas or in the applicant's country of residence.

All applicants must be resident and registered for a PhD, or in a first post-doctoral postion, in a country in the European Union. Only one application to the President's Fund may be made during the term of a postgraduate studentship or first post-doctoral postion. The full rules of the scheme are published on the SGM website, from which application forms may be downloaded.

Postgraduate Student Meetings Grants

Postgraduate Student Members of the Society currently resident in the UK or another European Union country are eligible for a grant to cover the costs of accommodation and travel in attending one of the following SGM meetings:

- University of Warwick, April 2000;
- University of Exeter, September 2000;

and any other Society Group or Branch meeting in 2000. An application form giving full details of the scheme was sent to each Student Member with their subscription invoice in October 1999. Student members should submit their applications well in advance of a meeting if they wish to ensure that the grant is received before making their booking.

Promega Young Life Scientist of the Year 2000

6 April 2000

University of Warwick

Hosted by the Genetical Society

The candidates for the 2000 competition have now been selected by the participating societies: Biochemical Society, Society for General Microbiology, Genetical Society, British Society for Immunology and British Society for Histocompatibility and Immunogenetics. Each contestant will give a short talk on their research.

Representing SGM will be:

- **Gina Manning**, Central Veterinary Laboratory, Surrey
- **Karen Isherwood**, CBD, Porton Down

The winner will receive a prize of £2,000 and a unique glass trophy.

The competition is sponsored by Promega to encourage excellence in communication by young life scientists.

Marjory Stephenson Prize Lecture

The 2000 Marjory Stephenson prize lecturer will be **Professor David W. Holden**, Hammersmith Hospital, London, in recognition of his distinguished contribution to the genetics of microbial pathogenesis. The title of his lecture, which will take place at the Society meeting at the University of Warwick in April 2000, is *In Vivo Genetic Analysis of Salmonella Virulence*.

David Holden obtained his first degree in Botany from Durham University in 1977, where he developed an interest in microbial genetics and plant disease. This led to a PhD at University College, London, on gene-for-gene interactions in the wheat-stem rust system, which he continued to study at the biochemical level as a postdoctoral researcher in Canada. He then moved to the University of Wisconsin on a second postdoctoral fellowship to learn molecular genetic methods and to apply them in the study of fungal pathogenesis. He returned to the UK in 1988, spending two years at the National Institute for Medical Research, before taking a lectureship at the Royal Postgraduate Medical School in London. Initially he worked on the opportunistic pathogen *Aspergillus fumigatus*, but following the development in his laboratory of Signature Tagged Mutagenesis (STM), his research has broadened out to include bacterial pathogens. He was awarded a personal chair in 1995. His laboratory now works on the functions of genes identified by STM in *Salmonella*, *Staphylococcus* and *Streptococcus*.

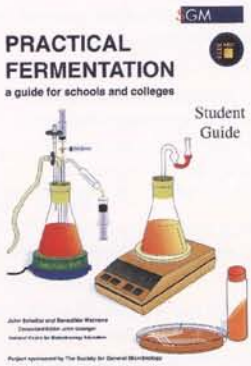
Fleming Lecture

The 2000 Fleming Lecture has been awarded to **Dr Peter Simmonds**, Department of Medical Microbiology, University of Edinburgh, in recognition of his contribution to virology. The title of his lecture, which will take place at the Society meeting at the University of Warwick in April 2000, is *The Origin and Evolution of Hepatitis Viruses in Humans*

I graduated from Southampton Medical School in 1982, completed my house jobs and decided to do a PhD. I had been fascinated by virology during the 4th year project supervised by John Heckels and Marie Ogilvie. As it was the only part of the course where I wasn't in the borderline pass/fail group, a career in research beckoned! I remain grateful to John Peutherer and Isabel Smith of the University of Edinburgh for offering to take me on as a very green PhD student in 1983, and I completed my thesis on HSV and HIV-1 serology in 1987. This was followed by a spell as a post-doc with Andrew Leigh Brown. Virus evolution has been the focus of my work since then. I became a Clinical Lecturer in 1990, squeezed in an MRCPath by exam in 1995, and stayed on to become a Reader in Virology at the University in 1998. A long time in the same place, but an interesting job so far. The recent joining of Edinburgh virology into a large single unit (Laboratory for Clinical and Molecular Virology) bodes well for the future.

Practical Fermentation

A guide for schools and colleges



Sponsored by the SGM, John Schollar and Bene Watmore of the National Centre for Biotechnology Education at the University of Reading have produced an excellent practical teaching resource on fermentation for schools. The set of 14 investigations is aimed at post 16 students following an advanced course in biology, particularly those taking an option in microbiology or biotechnology. A wide range of fermentations is covered and extension activities are suggested for each protocol. There are opportunities for data-logging and statistical analysis.

The pack consists of five student guides and two technical guides. The student guide is intended for those carrying out the investigations, whereas the technical guide is aimed at the teacher or technician, giving handy practical information and specimen results for most of the investigations. It also describes how to set up a bioreactor and how to use the NCBE's novel bubble logger. The Centre will be supplying equipment and cultures necessary for the investigations at economical prices.

Each pack costs only £15 (cheques payable to The University of Reading) and is available from NCBE (Orders), AMS, PO Box 228, The University of Reading, Whiteknights, Reading RG6 6AJ. For further details telephone 0118 987 3743.

UK University Microbiology Websites

Reg England (r.england@uclan.ac.uk), convener of the SGM Fermentation & Bioprocessing Group, has made a useful link to microbiology sites (mainly university sites) in the UK. It can be found at the following address

http://www.uclan.ac.uk/microresearch

Click on *Links* and it will take you to the relevant page.

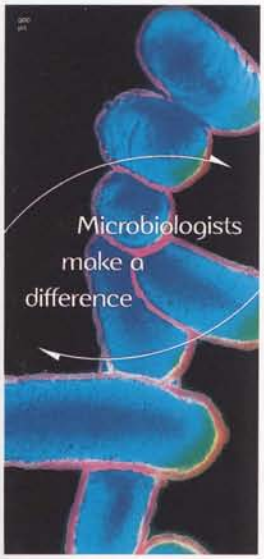
He would be very happy to add links to microbiology sites outside the UK.

A Printer Retires

Trevor Dunkley, managing director of the print division of Cambridge University Press, retired in January after 43 years service. For much of this time, CUP held the contract for printing the SGM journals. He is seen (right) being presented with a bottle of malt whisky by Ron Fraser, SGM Executive Secretary, at a lunch attended by SGM staff and a number of his colleagues from CUP.

Careers in Microbiology

New resources on careers are now available. The External Relations Office has produced an A3 poster, *Microbiologists Make a Difference*. It briefly describes the science of microbiology and outlines the types of work that microbiologists do and the training requirements. The poster has a colourful design aimed at attracting the attention of young people. It is accompanied by a leaflet with the same title which provides more in-depth information and a tear-off slip so that seriously interested readers can request a copy of the popular booklet *Careers in Microbiology*.



Copies of the poster and leaflet have been mailed to all UK and Irish secondary schools, local and university careers services and admissions tutors to undergraduate microbiology courses.

For further details e-mail **careers@sgm.ac.uk**

Careers information on the SGM website

A range of careers information has recently been mounted on the website (http://www.sgm.ac.uk). The page is divided into three sections:

- Careers in microbiology – a description of the range of careers opportunities that exist for microbiologists
- Careers information factsheets for microbiologists:
  - Information for students applying to university
  - Information for graduate microbiologists
  - Vacation work for microbiology students
  - Careers in the environment
  - Careers in medical microbiology
  - Careers for microbiologists out of the laboratory
  - Research careers for post-doctoral microbiologists
  - CVs and covering letters
  - Interview techniques
  - Technical training
- Links to careers websites

Click on the External Relations and Grants button and follow the links to the careers page. PDF versions are available for downloading if required.

New Members of Council

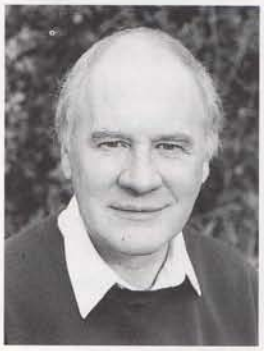
Colin R. Howard

I graduated as a zoologist from Durham University in 1970 and then attended the MSc in Virology in Birmingham, during which time I attended my first SGM meeting.

I then moved to the London School of Hygiene and Tropical Medicine where I completed my PhD in viral hepatitis and thereafter joined the academic staff where I remained until 1991. Nowadays my work revolves around novel vaccines and post-exposure immunotherapy, taking advantage of the facilities offered by the Royal Veterinary College, where I currently hold the chair in microbiology and am Vice-Principal for Research.

Dave J. Kelly

Originally a West Country boy from Bridgwater in Somerset, I did a degree in Applied Biology at Bath University, graduating in 1982. It was here that the likes of Ron Board and Tony Rose fired my interest in microbiology and I moved to the University of Warwick to undertake my PhD in Roger Whittenbury's department, under the supervision of the inimitable Crawford Dow. Here I studied the development of the photosynthetic apparatus and membranes during differentiation in the purple phototroph *Rhodomicrobium vannielii*. My interest in photosynthetic bacteria led to a (remarkably brief!) postdoctoral position with Baz Jackson and Stuart Ferguson at the University of Birmingham, applying molecular genetics to the study of anaerobic respiratory electron transport pathways in *Rhodobacter*. In 1986, David Tempest appointed me, at the tender age of 26, to a lectureship in the (then) Department of Microbiology at Sheffield University, and I have remained at Sheffield ever since, being promoted to senior lecturer in 1996, reader in 1998 and to a personal chair in 1999. My research interests have always centred around microbial physiology and metabolism, most recently in the human pathogens *Helicobacter pylori* and *Campylobacter jejuni*.



Ian R. Poxton

Born in Northumberland in 1949, Ian went to the University of Edinburgh and qualified with a BSc in Microbiology in 1971. This was followed by a PhD with Ian Sutherland completed in 1974. After a postdoctoral position in Newcastle with Sir James Baddiley, Ian returned to Edinburgh in 1977 as Lecturer, then Senior Lecturer (1989) and Reader (1993). He was awarded a DSc in 1992 and a personal chair in Microbial Infection and Immunity in 1999.

His main interests are bacterial pathogenicity and medical microbiology. Specifically he is interested in host response to lipopolysaccharide, anaerobic pathogens (*Clostridium* and *Bacteroides* spp.), mucosal immunity to gastrointestinal bacteria, including *Escherichia coli* O157, equine GI microbiology and immunology and aetiology of equine grass sickness.

Ian has been a member of SGM since 1972 and has served on the editorial board of JGM (1985–90) and committees of the Cell Surfaces & Membranes (1984–88) and Microbial Infection (1996–99) Groups. He is also Editor-in-Chief of *Reviews in Medical Microbiology*.

Outside interests include ornithology and climbing the 284 Munros.

Staff News

Congratulations to **Jane Westwell** of the External Relations Office on the birth of Isobel Margaret on 25 January, a sister for Eleanor. During Jane's absence on maternity leave we are pleased to welcome Sara Daw who will be handling grants administration and careers promotion activities.

Elections 2000

to Group Committees

A number of members of Group Committees retire in September 2000 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 opposite. In making nominations, members are particularly asked to bear in mind the desirability of a breadth of scientific interest on each committee. Nominations, including the general area of interest of the nominee, should be sent to reach the appropriate Group Convener **no later than 17 April 2000** (contact details on p. 39).

Cells & Cell Surfaces (5 Vacancies)

H.F. Jenkinson (C)* (Univ. Bristol)	Cell adhesion, yeast/bacterial transporters
J.P. Armitage (Univ. Oxford)	Bacterial motility and chemotaxis
S. Brul (Unilever, Vlaardingen)	Fungal cell walls, stress response
A.M. Carr* (Univ. Sussex)	DNA repair, yeast checkpoints
V. Koronakis* (Univ. Cambridge)	Expression and secretion of haemolysin
C.D. O'Connor (Univ. Southampton)	Stress adaptation, proteomics
P.B. Rainey (Univ. Oxford)	Plant-microbe interactions
A.W. Smith (Univ. Bath)	Antimicrobials and host responses
C.J. Stirling* (Univ. Manchester)	Membrane translocation, heat shock proteins
M. Wilson* (Eastman Dental Inst. London)	Oral biofilms, antimicrobials and cytokine induction
M.J. Woodward (MAFF Central Vet. Lab.)	Food-borne zoonoses
U. Desselberger (CR) (Addenbrooke's Hospital, Cambridge)	

Clinical Virology (3 Vacancies)

T.G. Wreghitt (Addenbrooke's Hospital, Cambridge)	Transplantation
D.W.G. Brown* (CPHL, London)	Exotic viruses, immunization
J. Connell (Virus Reference Laboratory, Dublin)	Diagnostic virology, hepatitis
R.P. Eglin* (PHL, Leeds)	Molecular diagnostics
C. McCaughey (Royal Victoria Hospital, Belfast)	Diagnostic virology, hantaviruses
P.J. Molyneaux (Aberdeen Royal Infirmary)	Diagnostic virology, hepatitis B
H.J. O'Neill* (Regional Virus Laboratory, Belfast)	Diagnostic and molecular virology
P.M.B. White (PHL, Norwich)	Public health, HLTV 1
G.B. Clements (CR) (Regional Virus Lab., Glasgow)	

Education (1 Vacancy)

P. Wyn-Jones (C) (Univ. Sunderland)	Health-related water virology
R.H. Bishop* (Univ. Ulster)	General and industrial microbiology
A.J. Cann (Univ. Leicester)	Molecular virology, web-based learning
T.G. Cartledge (Nottingham Trent Univ.)	Microbial physiology and molecular biology
I.W. Davidson (Unipath Ltd, Bedford)	Immunoassay, communication and public understanding
A.R. Eley (Univ. Sheffield)	Medical microbiology, chlamydial pathogenesis
P.S. Handley (Univ. Manchester)	Problem-based learning, environmental microbiology
J. Verran (Manchester Metropolitan Univ.)	Communication, group work skills, student-centred learning
R.E. Sockett (CR) (Univ. Nottingham)	

Environmental Microbiology (3 Vacancies)

H.M. Lappin-Scott (C) (Univ. Exeter)	Biofilms and starvation survival
A.S. Ball (Univ. Essex)	Soil microbiology, plant litter degradation, bioremediation
C.D. Clegg* (Scottish Crops Research Inst. Invergowrie)	Soil microbial ecology
K. Jones* (Univ. Lancaster)	Survival of pathogens and biofilms
L.A. Lawton* (Robert Gordon Univ. Aberdeen)	Toxic cyanobacteria
K.T. Semple (Univ. Lancaster)	Biodegradation, environmental pollutants, ecotoxicology, bioremediation
G.J.C. Underwood (Univ. Essex)	Biofilms, exopolymers, sediments, algae, nitrification
D.D. Wynn-Williams (British Antarctic Survey)	Antarctic cyanobacterial ecology, astrobiology
L.E. Macaskie (CR) (Univ. Birmingham)	

Fermentation and Bioprocessing (1 Vacancy)

R.R. England (C)* (Univ. Central Lancashire)	Bacterial physiology and signalling
N.J. Bainton (Univ. Surrey)	Bacterial signalling and communication
R.H. Cumming (Univ. Teesside)	Bioprocessing
M.J. Dempsey (Manchester Metropolitan Univ.)	Biochemical engineering
M.M.G. Duchars (Zeneca, Billingham)	Large-scale fermentation, recombinant technology
R.M. Hall (Glaxo-Wellcome, Stevenage)	Biotransformation, fermentation development, scale-up
G. Hobbs (Liverpool John Moores Univ.)	*Streptomyces* antibiotic production and morphology
D.J. Mead (Delta Biotechnology, Nottingham)	Applied microbial physiology, process control
G.P.C. Salmond (CR) (Univ. Cambridge)	

Irish Branch (3 Vacancies)

M.A. Collins (C) (Queen's Univ., Belfast)	Food microbiology
T.G. Barry* (Univ. College, Galway)	Molecular microbiology
A. Bell (Univ. Dublin)	Protozoal pathogens, *Plasmodium falciparum*
A.D.W. Dobson* (Univ. College, Cork)	Degradation of aromatics
E.M. Doyle (Univ. College, Dublin)	Applied enzymology, environmental biotechnology
K.A. Kavanagh* (St Patrick's, Maynooth)	Fungal infections of man
C. O'Reilly (Waterford Institute of Technology)	Microbial metabolism of cyanide and nitriles
N.G. Ternan (Univ. Ulster, Coleraine)	Environmental microbiology, biodegradation, organophosphonates, enzymology
A. Vivian (CR) (Univ. West of England)	

Microbial Infection (2 Vacancies)

P.W. Andrew (C) (Univ. Leicester)	Pathogenicity, *Listeria, Mycobacterium, Strep. pneumoniae*
M.R. Barer (Univ. Newcastle)	Bacterial physiology, infection, *M. tuberculosis, Salmonella*, STEC
D.A. Devine (Univ. Leeds)	Antimicrobial peptides, anaerobes, stress, biofilms
B. Henderson* (Eastman Dental Inst., London)	Cytokines, host–bacteria interactions
P.R. Langford (Imperial College, London)	Human/veterinary pathogens, proteomics, DNA arrays, meningitis
P.C.F. Oyston* (CBDE, Porton Down)	Bacterial pathogenicity, *Yersinia*, vaccines
L.J.V. Piddock (Univ. Birmingham)	Antibacteria action mechanisms, resistance
D.G.E. Smith (Royal 'Dick' School Vet. Medicine, Edinburgh)	Pathogenic mechanisms, bacterial pathogens of animals
I.R. Poxton (CR) (Univ. Edinburgh)	

Physiology, Biochemistry & Molecular Genetics (2 Vacancies)

D.A. Hodgson (C) (Univ. Warwick)	Molecular genetics and physiology
D.B. Archer (IFR, Norwich)	Protein secretion in filamentous fungi
A.J.P. Brown* (Univ. Aberdeen)	*Candida*, gene regulation
N.C. Bruce (Univ. Cambridge)	Biotransformation, microbial enzymology
S.J. Foster (Univ. Sheffield)	Cell walls, starvation survival
J.C. Gottschal (Univ. Groningen)	Bioremediation, physiology of starvation and competition
M.J. Larkin* (Queen's Univ. Belfast)	Biodegradation, survival
N.P. Minton (CAMR Porton Down)	Molecular genetics, industrial bacteria
C.E.D. Rees (Univ. Nottingham)	Environmental control, bacterial gene expression
S. Spiro (Univ. East Anglia)	Gene regulation, (de)nitrification
G.M. Stephens (UMIST, Manchester)	Microbial physiology, anaerobes, fermentation
E.M.H. Wellington (CR) (Univ. Warwick)	

Systematics & Evolution (3 Vacancies)

G. Saddler (C) (CABI, Egham)	Systematics of plant-pathogenic bacteria
C. Arnold* (CPHL, London)	Virus and bacterial evolution genome studies
B. Austin (Heriot-Watt, Edinburgh)	Taxonomy, ecology, fish pathogens, *Aeromonas, Vibrio*
J.G. Burgess* (Heriot-Watt, Edinburgh)	Marine microbiology
R. Goodacre (Univ. Wales, Aberystwyth)	Organism fingerprinting, molecular systematics, chemometrics
I.P. Thompson (IVEM, Oxford)	Microbial diversity and pollutant degradation
W. Wade* (Guy's & St. Thomas', London)	Oral bacteria, unculturables
A.C. Ward (Univ. Newcastle)	Data analysis in systematics and process control
D.McL. Roberts (CR) (Natural History Museum, London)	

Virus (4 Vacancies)

G.L. Smith (C) (Sir William Dunn School of Pathology, Oxford)	Poxviruses
G.E. Blair* (Univ. Leeds)	Adenoviruses
I. Brierley (Univ. Cambridge)	Coronaviruses, retroviruses, translation, RNA structure
I.N. Clarke (Univ. Southampton)	Caliciviruses, rotaviruses, microviridae, chlamidiaphage
D.J. Evans (Univ. Glasgow)	Picornaviruses, paramyxovirus replication, receptors, pathogenesis
R.D. Everett* (Inst. of Virology, Glasgow)	Herpesvirus
J.K. Fazakerley (Royal 'Dick' School Vet. Medicine, Edinburgh)	Pathogenesis, neurovirology, alphaviruses, picornaviruses, apoptosis
M. Harris (Univ. Leeds)	Retroviruses, hepatitis C
E. Hoey (Queen's Univ. Belfast)	Enteroviruses, molecular biology, picornavirus taxonomy
A.M. Lever* (Addenbrooke's Hospital, Cambridge)	Retrovirus
T. Wileman* (IAH, Pirbright)	African swine fever virus
R.M. Elliott (CR) (Inst. of Virology, Glasgow)	

(C) Convener
(CR) Council Representative
*Retiring 2000

Address Book

Council 1999–2000

Officers

President
PROF. HOWARD DALTON
Department of Biological Sciences,
University of Warwick,
Coventry CV4 7AL
Tel. 024 7652 3552
Fax 024 7652 3568/3701
e-mail hd@dna.bio.warwick.ac.uk

Treasurer
MR PETER F. STANBURY
Department of Biosciences,
Faculty of Natural Sciences,
University of Hertfordshire,
Hatfield Campus,
Hatfield AL10 9AB
Tel. 01707 284550
Fax 01707 285258
e-mail p.f.stanbury@herts.ac.uk

General Secretary
PROF. ALAN VIVIAN
Department of Biological and Biomedical Sciences,
University of the West of England,
Coldharbour Lane,
Bristol BS16 1QY
Tel. 0117 976 3834
Fax 0117 976 3871
e-mail alan.vivian@uwe.ac.uk

Scientific Meetings Officer
DR PAT M. GOODWIN
The Wellcome Trust,
183 Euston Road,
London NW1 2BE
Tel. 020 7611 8435
Fax 020 7611 8352
e-mail p.goodwin@wellcome.ac.uk

International Secretary
PROF. JEFF W. ALMOND
Senior Vice President of Research and Development,
Aventis Pasteur SA,
Campus Mérieux,
1541 Avenue Marcel Mérieux,
F-69280 Marcy-L'Etoile,
France
Tel. +33 4 3737 9453
Fax +33 4 3737 9157
e-mail jeffrey.almond@aventis.com

Professional Affairs Officer
PROF. DONALD A. RITCHIE
School of Biological Sciences,
Donnan Laboratories,
University of Liverpool,
Liverpool L69 7ZD
Tel. 0151 794 3624
Fax 0151 794 3655
e-mail d.a.ritchie@liverpool.ac.uk

Education Officer
DR LIZ SOCKETT
Genetics Division,
School of Clinical Laboratory Sciences,
Queen's Medical Centre,
University of Nottingham,
Nottingham NG7 2UH
Tel. 0115 919 4496
Fax 0115 970 9906
e-mail liz.sockett@nottingham.ac.uk

Editor, Microbiology Today
DR DAVE McL. ROBERTS
Department of Zoology,
The Natural History Museum,
Cromwell Road,
London SW7 5BD
Tel. 0207 942 5086
Fax 0207 942 5433
e-mail d.roberts@nhm.ac.uk

Editor-in-Chief, Microbiology
PROF. JON R. SAUNDERS
School of Biological Sciences,
Life Sciences Building,
University of Liverpool,
Liverpool L69 7ZB
Tel. 0151 794 4416
Fax 0151 794 4401
e-mail jrs@liverpool.ac.uk

Editor-in-Chief, JGV
PROF. STUART SIDDELL
Institute of Virology and Immunology,
University of Würzburg,
Versbacher Str. 7,
97078 Würzburg,
Germany
Tel. +49 931 201 3896
Fax +49 931 201 3970
e-mail siddell@vim.uni-wuerzburg.de

Members

DR GEOFF B. CLEMENTS
Regional Virus Laboratory,
Gartnavel General Hospital,
1053 Great Western Road,
Glasgow G12 0YN
Tel. 0141 211 0086
Fax 0141 211 0082

DR ULRICH DESSELBERGER
Regional Public Health Laboratory,
Level 6,
Addenbrooke's Hospital,
Hills Road,
Cambridge CB2 2QW
Tel. 01223 216816
Fax 01223 242775
e-mail ulrich.desselberger@msexc.addenbrookes.anglox.nhs.uk

PROF. RICHARD M. ELLIOTT
Institute of Virology,
University of Glasgow,
Church Street,
Glasgow G11 5JR
Tel. 0141 330 4024
Fax 0141 337 2236
e-mail elliott@vir.gla.ac.uk

DR COLIN R. HARWOOD
School of Microbiological, Immunological and Virological Sciences,
University of Newcastle,
Framlington Place,
Newcastle upon Tyne NE2 4HH
Tel. 0191 222 7708
Fax 0191 222 7736
e-mail colin.harwood@ncl.ac.uk

PROF. COLIN R. HOWARD
Department of Pathology & Infectious Diseases,
The Royal Veterinary College,
Royal College Street,
Camden,
London NW1 0TU
Tel. 0207 468 5302
Fax 0207 383 4670
e-mail choward@rvc.ac.uk

DR DAVE J. KELLY
Department of Molecular Biology & Biotechnology,
Krebs Institute
University of Sheffield
Firth Court,
Western Bank,
Sheffield S10 2TN
Tel. 0114 222 4414
Fax 0114 272 8697
e-mail d.kelly@sheffield.ac.uk

DR LYNNE E. MACASKIE
School of Biological Sciences,
University of Birmingham,
Edgbaston,
Birmingham B15 2TT
Tel. 0121 414 5889
Fax 0121 414 6557
e-mail l.e.macaskie@bham.ac.uk

PROF. IAN R. POXTON
Department of Medical Microbiology,
University of Edinburgh Medical School,
Teviot Place,
Edinburgh EH8 9AG
Tel. 0131 650 3128
Fax 0131 650 6531
e-mail i.r.poxton@ed.ac.uk

PROF. DAVE J. ROWLANDS
Department of Microbiology,
University of Leeds,
Leeds LS2 9JT
Tel. 0113 233 5641
Fax 0113 233 5638
e-mail d.j.rowlands@leeds.ac.uk

PROF. GEORGE P.C. SALMOND
Department of Biochemistry,
University of Cambridge,
Tennis Court Road,
Cambridge CB2 1QW
Tel. 01223 333650
Fax 01223 333345
e-mail gpcs@mole.bio.cam.ac.uk

PROF. CHRIS M. THOMAS
School of Biological Sciences,
University of Birmingham,
Edgbaston,
Birmingham B15 2TT
Tel. 0121 414 5903
Fax 0121 414 5925
e-mail c.m.thomas@bham.ac.uk

DR LIZ (E.M.H.) WELLINGTON
Department of Biological Sciences,
University of Warwick,
Coventry CV4 7AL
Tel. 024 7652 3184
Fax 024 7652 3701
e-mail eg@dna.bio.warwick.ac.uk

Group Conveners

Cells & Cell Surfaces
PROF. HOWARD JENKINSON
Department of Oral and Dental Science, Division of Oral Medicine, Pathology and Microbiology, University of Bristol Dental Hospital and School, Lower Maudlin Street, Bristol BS1 2LY
Tel. 0117 928 4358 (direct) / 0117 928 4304 (office)
Fax 0117 928 4428
e-mail howard.jenkinson@bristol.ac.uk

Clinical Virology
DR TIM WREGHITT
Clinical Microbiology and Public Health Laboratory,
Addenbrooke's Hospital, Cambridge CB2 2QW
Tel. 01223 257030
Fax 01223 242775
e-mail tim.wreghitt@msexc.addenbrookes.anglox.nhs.uk

Education
DR PETER WYN-JONES
School of Health Sciences, Darwin Building,
University of Sunderland, Wharncliffe Street, Sunderland SR1 3SD
Tel. 0191 515 2520
e-mail peter.wyn-jones@sunderland.ac.uk

Environmental Microbiology
PROF. HILARY M. LAPPIN-SCOTT
Department of Biological Sciences, Exeter University,
Hatherly Laboratories, Prince of Wales Road, Exeter EX4 4PS
Tel. 01392 263263
Fax 01392 263700
e-mail h.m.lappin-scott@exeter.ac.uk

Fermentation & Bioprocessing
DR REG R. ENGLAND
Department of Biological Sciences, University of Central Lancashire,
Corporation Street, Preston PR1 2HE
Tel. 01772 893513
Fax 01772 892929
e-mail r.england@uclan.ac.uk

Irish Branch
DR MARTIN A. COLLINS
Department of Food Science, Agriculture and Food Science Centre,
The Queen's University of Belfast, Newforge Lane,
Belfast BT9 5PX
Tel. 028 90 255314
Fax 028 90 668376
e-mail m.collins@qub.ac.uk

Microbial Infection
PROF. PETER ANDREW
Department of Microbiology and Immunology,
University of Leicester, Medical Sciences Building, PO Box 138,
University Road, Leicester LE1 9HN
Tel. 0116 252 2941
Fax 0116 252 5030
e-mail pwa@le.ac.uk

Physiology, Biochemistry & Molecular Genetics
DR DAVID A. HODGSON
Department of Biological Sciences, University of Warwick,
Coventry CV4 7AL
Tel. 024 7652 3559
Fax 024 76 52 3701
e-mail dm@dna.bio.warwick.ac.uk

Systematics & Evolution
DR GERRY SADDLER
CABI Bioscience, UK Centre (Egham), Bakeham Lane,
Egham, Surrey TW20 9TY
Tel. 01491 829065
Fax 01491 829100
e-mail g.saddler@cabi.org

Virus
PROF. GEOFFREY L. SMITH
Sir William Dunn School of Pathology, University of Oxford,
South Parks Road, Oxford OX1 3RE
Tel. 01865 275521 (direct) / 01865 275524 (secretary)
Fax 01865 275501
e-mail glsmith@molbiol.ox.ac.uk

Meetings

Meetings on the web

Up-to-date information on future Society meetings is available on the website:
http://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, Dr Pat Goodwin. Suggestions for topics for future symposia are always welcome. See p. 39 for contact details of Group Conveners. Administration of meetings is carried out by Mrs Josiane Dunn of the Meetings Office at SGM Headquarters, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AE
Tel. 0118 988 1805
Fax 0118 988 5656
e-mail meetings@sgm.ac.uk

Abstracts book

University of Surrey Meeting, January 2000

Virus Infection: Life or Death for a Cell

The full text of the abstracts book is now available as a PDF file on the SGM website.

Spring 2000

Millennium Meeting

University of Warwick, 10–14 April 2000 (joint with Society for Applied Microbiology)

● Main Symposium (10–11 April) Fighting Infection in the 21st Century

● PROGRAMME BOOKLET

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

● OFFERED POSTER PRESENTATIONS

Will delegates whose offered posters have been accepted please note that an area of **1m x 1m 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 either be brought to the meeting or sent beforehand to Janet Hurst at Marlborough House.

● PUBLIC DEBATE

1930 Wednesday, 12 April 2000
Arts Centre, University of Warwick

Infectious Disease: Will we ever win?

Motion
This house believes that microbial disease threatens the future of human life in the new millennium

The 20th century saw great advances in the diagnosis, understanding, prevention and cure of diseases caused by micro-organisms. Recent events have shown that scientists do not have all the answers. New diseases are threatening human health. Diseases thought to be under control, such as TB, have re-emerged. International travel enables harmful micro-organisms to spread quickly round the world. And the adaptability of pathogens which has led to antimicrobial-resistant 'superbugs' means that there is no longer a pill for every ill.

Will microbes always take the upper hand? Can scientists keep ahead? Or are we all doomed? Experts will explore the issues so that the audience can decide.

CHAIR: Dr Bernard Dixon

Delegates are welcome to join the debate.

Offered Papers

Offered posters are welcome but each one should be associated with a Group. General Offered Posters will no longer be accepted. Titles and abstracts should be sent to the appropriate Convener, preferably by e-mail. The subject content should be relevant to the remit of the Group (see website for details); it does not have to relate to the topic of the Group Symposium taking place at the particular meeting. Abstracts are required in a standard format – see website for details or contact the Events Administrator.

Promega Prize

Are you
- a member of the SGM?
- under 28 years of age?
- a postgraduate or first postdoc?
- thinking of presenting an offered paper or poster at an SGM meeting?

Why not enter for the Promega Prize Competition? You could win £200 in the SGM section of the competition and go on to compete for a further £2,000 in the *Young Life Scientist of the Year* event. Contact the Meetings Office or see website for details.

Future Meetings

AUTUMN 2000
147th Ordinary Meeting

University of Exeter 12–15 September 2000

● Main Symposium (12–13 September) Community Structure and Co-operation in Biofilms

Organizers: P. Gilbert, P.M. Goodwin, H.M. Lappin-Scott & M. Wilson

Speakers:
J. WIMPENNY (Cardiff) *Overview*
H.J. BUSSCHER (Groningen, The Netherlands) *Initial adhesion events*
D. DAVIES (Montana, USA) *Physiological events in early stages of biofilm formation*
P. STOODLEY (Exeter) *Factors influencing biofilm structure*
C. PICIOREANU (Delft, The Netherlands) *Modelling and predicting biofilm structure*
H.-C. FLEMMING (Mulheim, Germany) *Cohesiveness in biofilm matrix polymers*
P. KOLENBRANDER (NIH, USA) *Coadhesion in biofilms*
P. MARSH (CAMR) *Community interactions in biofilms*
L. EHLERS (Washington, USA) *Gene transfer in biofilms*
S. MOLIN (Denmark) *Probing complex biofilms*
G. WOOLFAARDT (Stellenbosch, S. Africa) *Biodegradation by biofilm communities*
R. BAYSTON (Nottingham) *Biofilms and prosthetic devices*
D. ALLISON (Manchester) *Problems of control*
H. LAPPIN-SCOTT (Exeter) *Detachment*
P. GILBERT (Manchester) *Population dynamics*
J. COSTERTON (Montana, USA) *Current status/future prospects*

● Other Symposia

● Applications of recombinant technology to industrial fermentations

Fermentation & Bioprocessing Group

Organizer: Matthew Duchars (matthew.duchars@avecia.com)

Please contact the Convener, Reg England (r.england@uclan.ac.uk), if you are interested in presenting a poster.

● Medical implications of biofilms

Cells & Cell Surfaces and Microbial Infection Groups

Organizers: D. Devine (ORL6DD@oralbio.novell.leeds.ac.uk) and M. Wilson (mwilson@eastman.ucl.ac.uk)

Day 1 a.m. Biofilms in implant-associated infections
Day 1 p.m. Oral biofilms
Day 2 a.m. Biofilms on shedding surfaces

● Mathematical skills and microbiologists

Education Group

Organizer: Ron Bishop (rh.bishop@ulst.ac.uk)

This half-day session will include talks, case studies and demonstrations.

● Evening Workshop

Biofilm formation and control

Environmental Microbiology Group

Organizer: Hilary Lappin-Scott h.m.lappin-scott@exeter.ac.uk
Offered papers are welcome, particularly from postgraduates and postdocs.

Keynote speaker: BILL KEEVIL
Biofilm control

The workshop will be followed by a YOUNG MEMBERS' RECEPTION.

● OFFERED POSTERS: the deadline for receipt of titles/abstracts is **12 May 2000**.

SPRING 2001 – 148th Ordinary Meeting

Heriot-Watt University, Edinburgh
24–30 March 2001

● Main Symposium New Challenges to Health: the Threat of Virus Infection

Organizers: P.M. Goodwin, W.L. Irving, J. McCauley, D.J. Rowlands & G.L. Smith

Other symposia include: Wall-less organisms/New enzyme targets for Anti-microbials/Microbiology of nitric oxide/Post-transcriptional control of gene expression/Microbe–pollutant interactions: biodegradation and bioremediation/Benchmarking in microbiology education

Evening workshop for young members: *Genomics*

● OFFERED POSTERS: the deadline for receipt of titles/abstracts is **17 November 2000**.

AUTUMN 2001 – 149th Ordinary Meeting

University of East Anglia
11–13 September

● Main Symposium Mycobacteria: New Developments

Organizers: M. Goodfellow, P.M. Goodwin, H.M. Lappin-Scott, G. Saddler & D. Smith

Other symposia include: Mobile elements in virulence/Microbial interactions in aquatic environments/Monitoring and control of fermentation processes/Microbial differentiation

Irish Branch

Recent Advances in Molecular Microbial Ecology

Ardilaun House Hotel, Galway
7–8 April 2000

Please note change of venue

Speakers:
7 April
M.EMBLEY (London) *Coastal sediment microbial processes – a molecular perspective*
K. SCHLEIFER (Munich, Germany) *Structural and functional in situ studies on bacterial communities*
J. MCINERNEY (Maynooth) *Microbial genomic analysis methods*
J. FLEMING (Tennessee, USA) *Differential display of prokaryotic mRNA: application to pure culture and soil microcosms*
8 April
J. PROSSER (Aberdeen) *Molecular ecology of nitrifying bacteria*
R. POWELL (Galway) *Molecular analysis of uncultured Archaebacteria in ocean waters*
M. CORMICAN (Galway) *Intensive care units think about microbial ecology*
S. GIOVANNONI (Oregon, USA) *Genomic approaches to bacterioplankton ecology*

Plus posters and conference dinner

Organizer: Tom Barry (thomas-barry@nuigal.ie)

Control of Infectious Disease and the Impact of Biotechnology

Royal Irish Academy, Dublin
11–12 May 2000

Organizer: Ron Bishop (rh.bishop@ulst.ac.uk)

Title t.b.c.

Belfast
19 May 2000

With Irish Diagnostics Group

Microbiology of Pulmonary Pathogens

National University of Ireland, Maynooth
7–8 September 2000

For details contact the organizer Kevin Kavanagh (kkavanagh@may.ie)

Title t.b.c.

Waterford Institute of Technology
January 2001

Postgraduate open paper session and two keynote speakers

Organizer: Catherine O'Reilly (coreilly@wit.ie)

Title t.b.c.

Trinity College, Dublin
March 2001

Joint with SGM Microbial Infection Group

For details of Irish Branch activities contact the Convener, Martin Collins (m.collins@qub.ac.uk)

Other News

European Virology 2000

Royal Concert Hall, Glasgow
17–21 September 2000

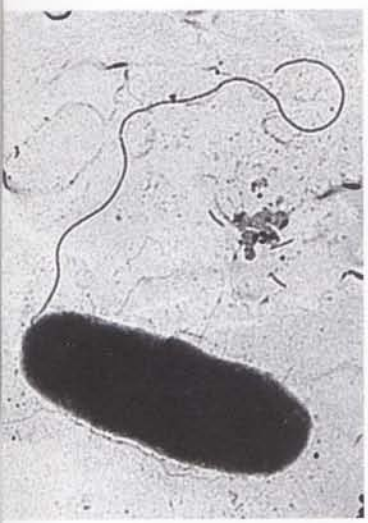
Supported by a wide range of European virology organizations, including the SGM, the meeting aims to provide a forum for basic researchers and clinical virologists to exchange insights and information and enhance interactions. It is hoped that 1,200+ delegates will attend from around the world. Each day the plenary sessions will be followed by four workshops with a keynote speaker and offered papers and posters.

Plenary sessions include:
Vaccines
Neurovirology
Hepatitis
Viruses & cancer
Respiratory viruses
Emerging/disappearing viruses
Viruses & the immune system.

Scholarships will be available for young scientists.

For further details and to register, see the website **www.euro-virology.com** or contact In Conference Ltd, 10B Broughton Street Lane, Edinburgh EH1 3LY Tel. 0131 556 9245; e-mail inconference@cableinet.co.uk

Hot off the Press

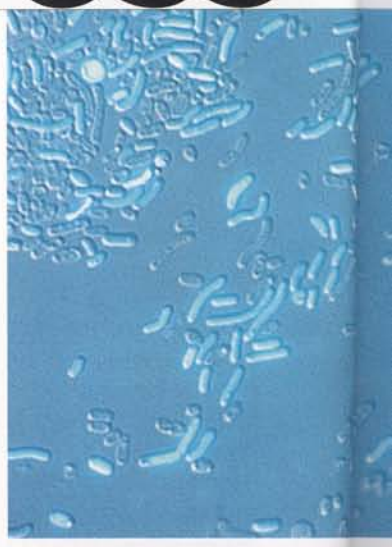


ABOVE:
Electron micrograph of a *Vibrio harveyi* cell.
BACKGROUND:
V. harveyi cells photographed under differential interference contrast (DIC) microscopy.
RIGHT TOP:
V. harveyi cells stained with 4′,6-diamidino-2-phenylindole (DAPI).
COURTESY GRZEGORZ WĘGRZYN, DEPARTMENT OF MOLECULAR BIOLOGY, UNIVERSITY OF GDANSK, POLAND

RIGHT CENTRE:
Sulphur jet in a high temperature area at Namaskard, Iceland.
COURTESY TRAVEL INK/ RICHARD KERVEN

RIGHT BOTTOM:
Transmission electron micrograph (C/Pt-shadowed) of *Modestobacter multiseptatus* strain AA-826^T after 13 days growth at 16 °C. Bar, 2 µm.
COURTESY PETER HIRSCH, INSTITUT FÜR ALLGEMEINE MIKROBIOLOGIE, UNIVERSITÄT KIEL, GERMANY

FAR RIGHT TOP:
Can viruses that cause disease in cats and dogs live in wild or zoo-bred carnivorous animals.
GST TECHNOLOGY LTD



Glowing in the dark

Quite a number of bacterial species can glow in the dark. This bioluminescence uses up a significant amount of energy, but no one knows why the bacteria do it. A group of Polish scientists have been studying one of these bacteria, *Vibrio harveyi*, for many years. It synthesizes a special enzyme, luciferase, along with its fat-like substrate. Luciferase has the ability to convert chemical energy into light, and so the bacteria glow gently as they swim in the sea. Over the years, the Polish researchers have acquired many mutant strains of *V. harveyi*. They noticed that some of them were easily killed by ultraviolet (UV) light and that most of these mutants had simultaneously lost the ability to emit light. Non-luminescent *V. harveyi* cells were killed by half the level of UV light needed to kill normal cells. Could there be a connection?

Varying amounts of UV light reach the Earth's surface, but it is dangerous enough for all creatures to need some way to protect themselves from it. This ranges from the melanin in human skin to systems within cells to repair damage to key molecules like DNA. UV light can penetrate into water, so *V. harveyi* cannot escape. Indeed, UV light can stimulate bioluminescence in *V. harveyi*.

It has been known for many years that bacteria can make use of sunlight to help them repair the damage caused by UV light, so the Poles wondered if *V. harveyi* could use its bioluminescence as an internal source of light. This could be particularly useful for bacteria in the sea where daylight may not penetrate. To test this idea, they transferred the genes for the bioluminescence system into *Escherichia coli*. This bacterium usually cannot glow, but the ways in which it repairs damaged DNA are very well known. Once the *V. harveyi* genes were in place, the *E. coli* cells both glowed and were less sensitive to UV light.

Perhaps bioluminescence does indeed give bacterial cells a portable light to use in making repairs.

■ **Czyż, A., Wróbel, B. & Węgrzyn, G. (2000).** *Vibrio harveyi* bioluminescence plays a role in stimulation of DNA repair. *Microbiology* **146**, 283–288.

Out of Africa

How can you tell if a new viral disease is really new, or simply a variation on an old theme?

For example, o'nyong-nyong virus (ONN), although first identified in 1959, swept across East Africa in its first major outbreak in 1996 and affected over 2 million people. This virus is closely related to chikungunya (CHIK) virus, which has caused repeated epidemics in both Africa and Southeast Asia since the 1950s. They both produce an illness in humans where the symptoms of fever, headache and nausea are very similar to those of a third viral disease, dengue fever.

Apart from the need to distinguish the three for public health reasons, the relationship between CHIK and ONN is important. If ONN is actually a new variant of CHIK, this could have implications for the future of these diseases. In Africa CHIK is maintained in a forest cycle between wild primates and several species of mosquitoes. In Asia it is found exclusively in people and the urban mosquito *Aedes aegypti*. The ONN virus has also only been found in people, but is transmitted by a different group of mosquitoes. These are the anopheline mosquitoes that inhabit tropical Africa and live in close association with humans.

Scientists in the Center for Tropical Diseases at the University of Texas analysed samples of CHIK and ONN viruses that had been collected since the 1950s. They worked out the DNA sequence of part of the viral genes, the best way of telling which virus is which, and this allowed them to see the degree of similarity between samples from countries as far apart as Nigeria, South Africa, Thailand and Indonesia. Some of the samples came from people reported to be suffering from dengue fever, but when the researchers analysed the virus, it was obviously from an infection with CHIK.

The CHIK viruses fell into three distinct groups, based on their geographical origins. There was a West African group, another distinct type in central and eastern Africa, and a third type in Asia. This fitted very nicely with historical evidence that the CHIK virus was introduced into Asia from Africa. The ONN samples all fell into a fourth group that was so different from the other three that it must be thousands of years since the CHIK and ONN viruses last shared a common ancestor. So, although CHIK has split into several distinct varieties in the last few hundred years, ONN virus is not one of them.

■ **Powers, A. M., Brault, A. C., Tesh, R. B. & Weaver, S. C. (2000).** Re-emergence of chikungunya and o'nyong-nyong viruses: evidence for distinct geographical lineages and distant evolutionary relationships. *J Gen Virol* **81**, 471–479.

Fire and ice

Pinning down which species a bacterium belongs to is not always easy. The genus *Thermus* is a particular problem. Its members include the few bacteria that enjoy a life at temperatures above 55 °C and a pH above 9·0, so assigning them to this genus is not so difficult. The difficulty is to fix on a species. Biochemical and physiological characteristics are not very useful, and even cell shape and fat composition can vary within a species. DNA features are now used as the definitive guideline and have brought a new certainty to *Thermus* identification.

An international group of researchers, supported by the European Union, has been collecting *Thermus* species from Icelandic hot springs where the water is over 70 °C. They tested their yellow-coloured bacterial colonies alongside authentic *Thermus* isolates for many physiological attributes as well as for characteristic DNA sequences. The DNA gave a clear-cut result, supported by a particular fat composition and the fact that the new isolate could grow at 80 °C. The scientists had discovered two novel *Thermus* species. To acknowledge their origin, one has been called *Thermus igniterrae*, after Iceland, the land of fire. The other has been named *Thermus antranikianii* after the scientist Garabed Antranikian who has contributed to our understanding of heat-loving organisms.

■ **Chung, A. P., Rainey, F. A., Valente, M., Nobre, M. F. & da Costa, M. S. (2000).** *Thermus igniterrae* sp. nov. and *Thermus antranikianii* sp. nov., two new species from Iceland. *Int J Syst Evol Microbiol* **50**, 209–217.

One of the few ice-free regions in Antarctica is the 7,000 km^2 McMurdo Dry Valleys. The summer temperature occasionally gets up to 0 °C, while in winter it can drop to −60 °C. The little snow that does fall is hardly enough to moisten the thin soil. This dry, cold desert lacks any visible life, apart from a few lichens. For a time, scientists thought that the soil micro-organisms were recent arrivals brought by humans. Now, they know better. Authentic Antarctic bacteria live in the soil and inside rocks, both of which can become warm during the long summer days. A recent expedition by German scientists has detected a new genus of actinomycete in the soil.

They transported frozen soil back to their laboratory in Kiel, added a very dilute growth medium, incubated it at 9 °C, and looked for up to a year to see what would grow. Amongst the bacteria were some small rod-shaped or spherical cells that tended to stick together. They could multiply by budding, or from the cells separating at cross or longitudinal walls. A battery of biochemical, physiological and DNA tests showed that all isolates with this morphology were similar enough to be considered members of the same species. Although they had characteristics of the family *Geodermatophilaceae*, there were sufficient differences from existing members to mean that the species had to be one of a new genus. In recognition of the modest food requirements of the strains, the researchers called it *Modestobacter*.

■ **Mevs, U., Stackebrandt, E., Schumann, P., Gallikowski, C. A. & Hirsch, P. (2000).** *Modestobacter multiseptatus* gen. nov., sp. nov., a budding actinomycete from soils of the Asgard Range (Transantarctic Mountains). *Int J Syst Evol Microbiol* **50**, 337–346.

Cats and dogs

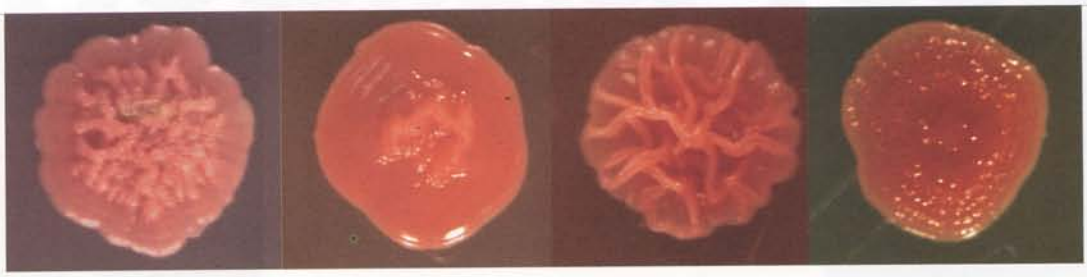
As well as worrying about new viral diseases spreading from wild animals to people, there are concerns about diseases moving in the opposite direction. Maybe not from people, but certainly from our domestic animals. An international collaboration between scientists in Germany, South Africa and the USA has been testing whether viruses that cause disease in cats and dogs can live in wild or zoo-bred carnivorous animals.

They were concerned about parvoviruses that cause damage to the white blood cells and intestinal tract, producing symptoms of fever, diarrhoea and vomiting. One of them, feline panleukopenia virus (FPV) causes feline distemper and was identified early in the twentieth century. Vaccination against it is recommended for all pet cats. Another, canine parvovirus (CPV-2) emerged suddenly in the late 1970s and spread worldwide in a few months, killing thousands of dogs. The two viruses are very similar. Indeed the ability of one to infect dogs and the other cats is determined by a mere six differences in their genetic code. New variants of CPV-2 soon appeared which have replaced the original virus. These new variants (CPV-2a and CPV-2b) can infect both cats and dogs.

The researchers looked for these viruses in droppings or tissue samples from 18 sick animals. Some of these were from truly wild animals, like diarrhoeal droppings left by honey badgers in the Kalahari Gemsbok National Park or two African wild cats that were taken to an animal rescue centre near Pretoria. Other samples were from zoos, including five cheetahs in America and a Siberian tiger from Germany.

The complete DNA sequence is known for these parvoviruses, so the researchers could use the sensitive polymerase chain reaction to look for each of the four viruses. Ten of the animals contained DNA characteristic of FPV, CPV-2a or CPV-2b. Along with the disease symptoms, this indicates that the viruses take an unfortunately broad view of suitable hosts. The question of how the animals acquired the infections is more difficult to answer. The viruses survive for a long time in the environment and are shed in vast numbers by infected cats and dogs. It is easy to imagine that stray cats and dogs could easily bring the viruses to captive animals. The cheetahs from the American zoos had been vaccinated against FPV to protect them from precisely this risk. Unfortunately, four of them had contracted CPV-2b.

■ **Steinel, A., Munson, L., van Vuuren, M. & Truyen, U. (2000).** Genetic characterization of feline parvovirus sequences from various carnivores. *J Gen Virol* **81**, 345–350.



ABOVE RIGHT:
Colonies of representative haloarchaeal isolates from Permo-Triassic rock salt, grown for 4–5 months on agar plates with nutrients and 20 % NaCl.
COURTESY PROFESSOR HELGA STAN-LOTTER, INSTITUTE OF GENETICS AND GENERAL BIOLOGY, UNIVERSITY OF SALZBURG, AUSTRIA

BELOW:
Scanning electron micrograph of *Candida albicans* coaggregating with streptococci.
COURTESY DR RICHARD CANNON, DEPARTMENT OF ORAL SCIENCES AND ORTHODONTICS, UNIVERSITY OF OTAGO, NEW ZEALAND

Dung lovin' thermophile

Streptomycete bacteria are particularly attractive to anyone looking for useful chemicals. They produce many antibiotics, as well as enzymes exploited in processes as diverse as paper-making and washing clothes. Researchers at the University of Malaya found an interesting one among the chicken droppings on the university poultry farm. This produced a particularly pure form of the enzyme xylanase, which degrades one of the components of wood. It also grew best at 45 °C and this ability marked it as a thermophilic streptomycete.

The property of growing at high temperature has evolved at least twice in the streptomycetes, so identification of the new strain had to check a number of characteristics. The Malaysians worked with Michael Goodfellow of the University of Newcastle in the UK to do this. They analysed the composition of the cell wall, as well as the size of some fats. Finally, they sequenced a long segment of DNA and matched it against a large database of other streptomycete sequences.

As the researchers had anticipated, the new strain's characteristics fell within one group of thermophiles. However, its combination of DNA and chemical features was sufficiently different to make it a new species, for which they coined the name *Streptomyces thermocoprophilus*.

■ **Kim, B., Al-Tai, A. M., Kim, S. B., Somasundaram, P. & Goodfellow, M. (2000).** *Streptomyces thermocoprophilus* sp. nov., a cellulase-free endo-xylanase-producing streptomycete. *Int J Syst Evol Microbiol* **50**, in press.

The SGM publishes two monthly journals, ***Microbiology*** and ***Journal of General Virology***.

The ***International Journal of Systematic and Evolutionary Microbiology*** (***IJSEM***, formerly ***IJSB***) is published bimonthly on behalf of the IUMS in conjunction with the ICSB.

The three journals are now available online. For further information visit the journal website: **http://www.sgmjournals.org**

Members may purchase SGM journals at concessionary rates. See p. 1 or contact the Membership Office for details. Information on commercial subscriptions is available from the Journals Sales Office.

Stuck on you

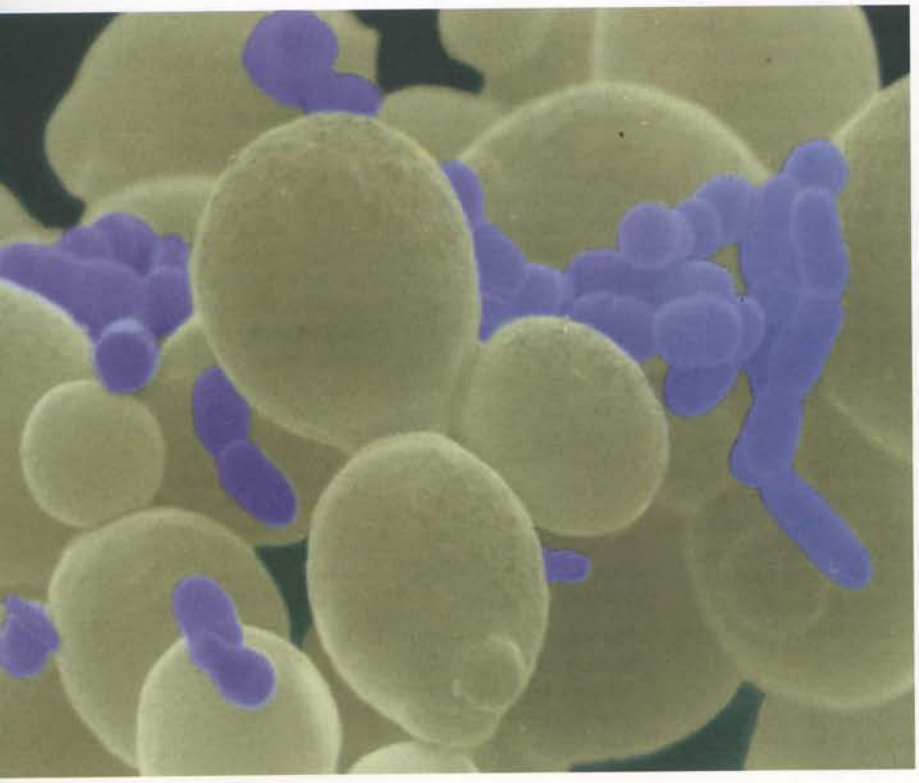
The fungus *Candida albicans* is an opportunistic human pathogen. Most of the time it lives quietly, without causing any problems. One of its homes is inside the mouth. For a microbe, this habitat provides a challenge: to remain there as waves of food, drink and saliva wash through. An ability to find and stick to surfaces is useful. A group of New Zealand researchers have been working out how *C. albicans* exploits both saliva and bacteria to maintain a toehold.

Saliva contains a mixture of proteins, some needed to start off digestion, others with an unknown rôle. Some will stick to cells and teeth, and change shape when they do so. They will even attach to the acrylic surface of dentures. The streptococcal bacteria that live within the mouth have several ways of clinging on. Sometimes, they use the shape of the salivary proteins to work out whether they have found a surface or are still floating.

C. albicans can use these pioneering bacteria as its own target. As the researchers discovered, it would attach tenaciously to some of them and would cling even better in the presence of saliva. They wanted to find out which of the many salivary proteins were involved. They concentrated on one group, the basic proline-rich proteins (bPRPs) which they already knew bound to streptococci.

A series of experiments were carried out mixing individual species of streptococci and saliva to see how well *C. albicans* stuck onto each of them. They found that different streptococci became coated with different bPRPs. *C. albicans* was choosy about which streptococcal species it clung to, ignoring one like *Streptococcus mutans*, but attaching avidly to *Streptococcus oralis*. Saliva could more than double the amount of *C. albicans* that clung onto the bacteria, and indeed some individual bPRPs alone were enough to allow *C. albicans* to adhere to an artificial surface. It looks like *C. albicans*, knowing that it must attach to something inside the mouth, recognizes a saliva coating on both bacteria and mouth tissue for the widest possible opportunity to find a suitable home.

■ **O'Sullivan, J. M., Jenkinson, H. F. & Cannon, R. D. (2000).** Adhesion of *Candida albicans* to oral streptococci is promoted by selective adsorption of salivary proteins to the streptococcal cell surface. *Microbiology* **146**, 41–48.



'Permo-Triassic Park'

In the film *Jurassic Park*, scientists use dinosaur blood preserved within a fossilized mosquito to re-create living dinosaurs. In real life it seems impossible that DNA can last for millions of years as the long molecule required in a living creature. Short pieces certainly survive, but a living cell requires lengths of hundreds of thousands of bases. As well as fragmentation by digestive enzymes immediately after death, damage from chemical reactions and radiation can only accumulate in dead cells over geological time. Living cells are constantly repairing their DNA, but cannot exist for millions of years.

However, a group of microbiologists have been carrying out experiments that challenge this assumption. They have been studying living bacteria that have apparently been entombed in salt for millions of years. In the early 1990s they reported bacteria obtained from samples of freshly mined rock salt from deep under the surface in Austria. They called them *Halococcus salifodinae*. The existence of these bacteria is not in doubt. The arguments centre on whether they have really been revived after up to 250 million years, or are a contaminant from the modern environment.

These bacteria require an almost saturated solution of common salt in their growth environment. Very few bacteria can survive under these conditions, let alone multiply. This kind of extreme halophile has been found in unusual places like the Dead Sea. They have been seen swimming around within sea-salt crystals, as well as surviving on the skin of salted fish.

As one way of testing an ancient origin of *H. salifodinae*, the Austrian and German researchers have now compared their original strain with new isolates from the same mine, as well as bacteria found in German and Cheshire salt mines. Geologists are fairly confident that all these salt deposits originated from the same sea that dried up during the Permo-Triassic period.

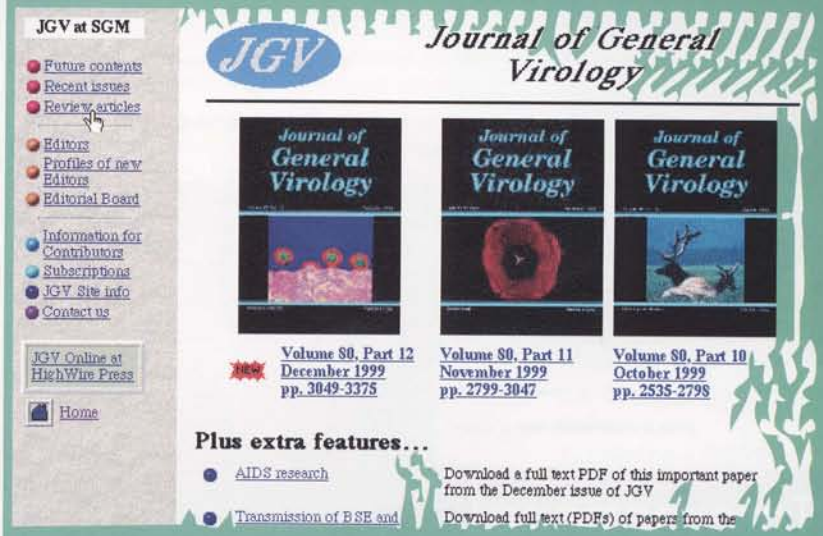
They analysed many chemical characteristics of the bacteria as well as sequencing long lengths of DNA. All the strains were very similar to each other and distinctly different from all other extreme halophiles. The strains even looked the same, with thick-walled, pinkish, round cells. The researchers' hypothesis is that *H. salifodinae* has survived within pockets of liquid within the rock-salt, dormant until revived in the modern laboratory. The possibility that it has really survived unchanged for hundreds of millions of years is something that scientists are going to continue to argue about well into the 21st century.

■ **Stan-Lotter, H., McGenity, T. J., Legat, A., Denner, E. B. M., Glaser, K., Stetter, K. O. & Wanner, G. (1999).** Very similar strains of *Halococcus salifodinae* are found in geographically separated Permo-Triassic salt deposits. *Microbiology* 145, 3565–3574.

JGV website news

In addition to JGV Online (http://vir.sgmjournals.org), our full-text multi-featured website in association with HighWire Press, ***Journal of General Virology*** has its own Internet presence within the SGM website. The JGV Editorial Office staff have recently taken over responsibility for these pages and have given them a complete make-over. The JGV at SGM pages have been redesigned to make them both user-friendly and attractive. Extra information has been added (e.g. full-text PDFs of selected topical papers) and a new navigation panel included to make accessing the pages easier then ever. These pages are free to all! Take a look and tell us what you think!

http://www.sgm.ac.uk/vir_main.htm



Microbiology (http://www.sgm.ac.uk/mic_main.htm) and ***International Journal of Systematic and Evolutionary Microbiology*** (http://www.sgm.ac.uk/ijsemmain.htm) pages are also being redesigned in the near future. Contact the relevant Editorial Office for further details.

Second US Editor for JGV

Journal of General Virology (JGV) has appointed its second Editor in the United States.

Dr John Schiller works at the National Cancer Institute, National Institutes of Health, in Bethesda, Maryland. He studies papillomaviruses, focusing especially on the virion proteins and the development of virus-like particle-based vaccines. He will assume primary responsibility for editing papovavirus manuscripts.

John studied molecular biology at the University of Wisconsin, in his home town of Madison, and received his PhD from the University of Washington for research into antibiotic gene transfer in corynebacteria. He began his papillomavirus studies in 1983 as a postdoctoral fellow of Douglas Lowy at the NIH, and has remained a member of the NCI intramural program, currently as a Section Chief in the Laboratory of Cellular Oncology. He has studied several aspects of papillomavirus biology, including cell transformation, transcription regulation and host immune response.

The appointment of Dr Schiller continues JGV's policy of establishing a top-class worldwide panel of Editors.

New submissions to JGV in this field may be sent directly to:

John Schiller
National Cancer Institute
National Institutes of Health
Bldg 36, Rm 1D32
Bethesda
MD 20892-4040
USA

Fax +1 301 480 5322
e-mail schillej@dc37a.nci.nih.gov

A short history of the official journal of bacterial names

Aidan Parte

In the year 2000, the *International Journal of Systematic and Evolutionary Microbiology* (IJSEM) was born. However, there is a 50 year history behind the journal...

Founded in 1951 as the *International Bulletin of Bacterial Nomenclature and Taxonomy*, the official organ of the Judicial Commission and of the International Committee on Bacteriological Nomenclature of the International Association of Microbiologists was published by Iowa State College Press. Its aim was 'to contribute to the stabilization of bacteriological nomenclature by opening up a channel of free communication between those concerned in the naming and classification of bacteria.' The original Editorial Board comprised the eminent bacteriologists R.E. Buchanan, Robert S. Breed and S.T. Cowan.

In 1966, the official journal became the *International Journal of Systematic Bacteriology* (IJSB), a name that has stayed until the final issue of 1999. The IJSB has grown steadily over the years, consolidating its position as the world's premier microbial systematics journal. During this period, the IJSB has had two changes of publishers, firstly to the American Society for Microbiology (ASM), and then to the Society for General Microbiology (SGM) in late 1997.

Back in 1996, the International Committee on Systematic Bacteriology first proposed renaming the journal as the *International Journal of Systematic and Evolutionary Microbiology* and the January issue was the first issue. The change in name was partly to acknowledge the fact that for many years the journal has covered the systematics of yeasts and also to highlight the decision to expand the journal's subject area to cover the evolution and phylogeny of all micro-organisms, including the protists such as protozoa and algae. The journal will also publish molecular environmental papers with a strong systematics content.

What of the future for the official journal and the subject of systematics?

The increasing interest in the field of microbial systematics during the last few years, facilitated by 16S rRNA analysis, has led to a large increase in the number of pages published in the journal. For this reason, and to reduce publication times the journal has become a bimonthly publication.

Traditional scientific publishing has seen major changes brought about by new technology; the journal has embraced these developments, and will continue to do so in the future. Taxonomy will be affected too: the various Codes of Nomenclature will need amendment to allow effective and valid publication in electronic-only journals.

So, the future looks bright.

At the present rate of description of new microbial species the journal should continue to exist, in one form or another, for at least a thousand years!

● *Aidan Parte, Managing Editor, IJSEM*

Review
Transport of molecules across microbial membranes

This volume represents the SGM symposium held in Leeds in September 1999 on the topic of molecular transport in prokaryotic and eukaryotic microbes.

The introductory chapter by Broome-Smith & Mitsopoulos is an overview of fundamental problems in microbial transport and sets the scene for the rest of the volume. Cursory discussion of at least one of several topics missing from the individual chapters, e.g. Type I protein secretion, is included.

The chapter by Lewis summarizes the physiological importance of multidrug efflux systems. All organisms have such pumps (MDRs) and multiple pumps can co-exist in the same cell. Lewis raises the key question of the mechanism of substrate recognition, though with little hope of finding a solution in the near future. Nevertheless, better knowledge of MDR pumps might lead to insights into virulence mechanisms and to identification of inhibitory antimicrobials.

Poolman reviews the regulation of solute transport in bacteria, treating us to the bioenergetics of transport and regulation of solute transport via internal pH, accessory proteins and phosphorylation. The rôle of osmoregulation, in uptake and excretion, is also discussed.

The chapter on arsenic transporters (from *E. coli* to man) by Barry Rosen, although equally lucid, does not capture the impact of the stylish colour presentation at the meeting. He covers the evolution of transport processes associated with resistance to arsenicals and antimonials and shows that these processes were 'reinvented' several times in evolution.

Alain Filloux summarizes Type II protein secretion. He discusses distribution of the Type II apparatus in various bacteria and the evolutionary connections between Type IV pilus assembly systems and 'pseudopilin' components of the Type II pathway. Recent progress has been made in defining the nature of the outer-membrane 'pore' made by the 'secretins' of the Type II system. The mechanisms involved in gating the secretin pore remain mysterious.

Outer-membrane secretins also appear in the Type III secretion pathway. Anderson *et al.* discuss the rôle of this pathway in the pathogen *Yersinia*. The Type III plasmid-encoded system is involved in targeting virulence factors directly into the cytosol of recipient animal cells, perhaps akin to a miniature hypodermic syringe. Again, evolutionary arguments reveal interesting common features between assembly of part of the Type III machinery and the process of flagellum construction.

Soto & Hultgren review bacterial adhesin assembly, concentrating on P pili (on uropathogenic *E. coli* strains) and Type I pili (virulence determinants on the surface of several enteric bacteria). The fascinating theme linking these pili is the use of molecular chaperones and 'ushers' and the control processes in which they act during pilus assembly.

Sanford Lacks summarizes knowledge about transformation in a thorough review of the key issues involved – attachment, DNA degradation, single-strand entry, energetic requirements and recombination and restriction. The regulation of competence via small molecules and the induction of competence genes is also reviewed. There are echoes of the Type II secretion system in this story, reiterating the notion of common themes in the evolution of transport systems.

Valent *et al.* present a historical perspective on the *E. coli* equivalent of the signal recognition particle (SRP), including elucidation of FtsY and Ffh functions. Here is an example where research in mammalian systems led to a fundamental discovery about protein translocation mechanisms years before a similar bacterial system was found, highlighting the need for microbiologists to be aware of biological processes in higher organisms, since similar processes are often found in prokaryotes. Indeed, later chapters reinforce this idea.

Young *et al.* discuss protein translocation into the endoplasmic reticulum. Many of the studies discussed are on yeast and have exploited genetics in a powerful dissection of the targeting machinery (the translocon), coupled with reconstitution assays. The authors highlight the impressive progress made in this field over the past decade, though many questions still require answers.

Lopez-Huertas & Baker provide a thorough chapter on peroxisome biogenesis. Initially historical, this review covers peroxisomal targeting signals, bioenergetic requirements and the nature of the import machinery. A characteristic of this system is that folded proteins and oligomeric species can be imported. This notion of membrane translocation via folded proteins is now no longer considered bizarre with the accumulation of data on membrane translocation of various fully folded proteins in eukaryotic and prokaryotic systems.

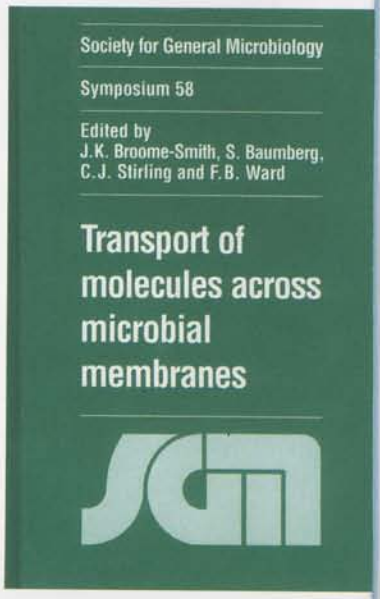
Robinson *et al.* present a chapter on transport of proteins into and across the thylakoid membrane, neatly summarizing the field. Examples are given of the various pathways taken by different proteins, including a discussion of the ΔpH-driven pathway for folded proteins and the corresponding process, recently discovered in bacteria. The chapter concludes with some interesting points about the relative merits and difficulties of studying protein translocation mechanisms in bacteria and higher organisms – a multivariate approach might be the best way forward in future.

The book ends with a stimulating chapter from Saier & Tseng on the evolutionary origins of transport systems, with several surprises about the likely evolutionary origin and frequency of 'genesis' of permease families, topological constraints operating in membrane transporters, and mosaic and modular construction. This topic – how it all started, how it may have evolved and how it may evolve in future – is a fitting terminal chapter to the symposium volume.

Typographical errors are very rare, though there is the occasional error of fact. Yes, there are several important topics missing. However, this is a large and important research field and it would be impossible to cover it comprehensively without a week-long symposium and an associated volume three or four times the size of this one.

Overall, this volume is a useful contribution to the literature on microbial transport and could serve as a fast-track into the topic for the non-cognoscenti. Common themes emerge strongly in this book. One is the need to understand molecular recognition in transport systems. Another is that prokaryotic and eukaryotic systems use similar mechanisms in the limited selection of transport processes that we currently understand. It's really the old story – when evolution gets a good idea it disseminates it widely.

● *Professor George Salmond, SGM Council*



SGM Symposium Volume 58

Edited by
J.K. Broome-Smith,
S. Baumberg,
C.J. Stirling & F.B. Ward

Published by
Cambridge University
Press (1999)

Members
£26.00/US$46.00;
Non-members
£65.00/US$115.00;
Student members
£16.00, pp. 279

ISBN: 0-521-77270-2

An order form for Symposium Volumes may be downloaded from the SGM website **www.sgm.ac.uk**

New educational resources from the American Society for Microbiology

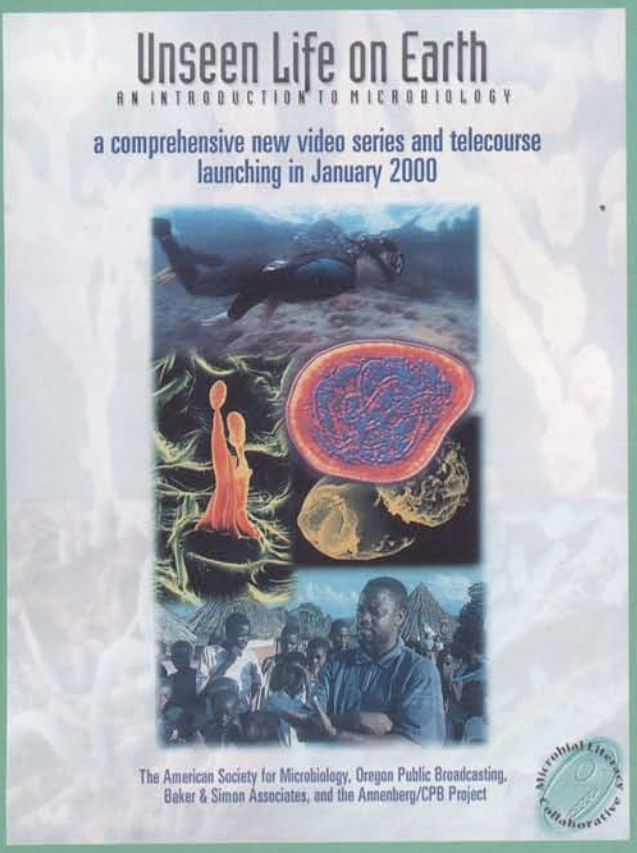
Members of the External Relations Office at the SGM were pleased to meet Denise Steene of the ASM Education Department during her recent sabbatical in the UK. It was useful to exchange information and experiences and hopefully there will be greater collaboration between the two learned societies in future. Two of the recent exciting initiatives from the ASM are described here.

Unseen Life on Earth

The Microbial Literacy Collective (MLC) was founded by the ASM to provide a means to educate the public about micro-organisms and present both the positive and negative contributions microbes make to the world. *Intimate Strangers: Unseen Life on Earth*, a 4 hour science documentary for public television (recently shown on public broadcasting stations in the USA) is the centrepiece of the MLC's initiatives. The themes of the series are Tree of life, Keepers of the biosphere, Dangerous friends and friendly enemies and Creators of the future.

Another product of the MLC, *Unseen Life on Earth: An Introduction to Microbiology*, a set of 12 video programmes with accompanying textbooks and study guides, is intended as the first course in microbiology for students of biology, allied health, nursing, dentistry and microbiology, in 2- and 4-year courses in American colleges and universities. The programmes are also intended to be used as a course for distance learners, an integrated course for 2- and 4-year programmes, or a supplement to microbiology courses taught to more advanced students.

The scientific content of the video programmes is based on a consensus curriculum identified by the faculty of introductory microbiology through the ASM's annual undergraduate education conference (http://www.asmusa.org/edusrc/edu32a.htm#Core). The five core themes are: Microbial cell biology, Microbial genetics, Interactions of micro-organisms and humans, Interactions of micro-organisms in the environment and Microbial diversity and evolution.



Units 1 and 2 of the telecourse address the breadth of the microbial world and its relation to the rest of global life, with emphasis on the similarities and differences among Earth's many life forms. Units 3–5 examine the physiology, genetics and biotechnological uses of micro-organisms. Mixtures of stories, animations and high quality graphics illustrate these very technical principles that are often difficult to teach in the traditional lecture-style format. Units 6–8 discuss microbial evolution, its relation to the evolution of all life and the great diversity in the microbial world and how we study it, as well as the myriad rôles microbes play in ecosystems. Unit 9 addresses practical issues of how we control micro-organisms in places ranging from kitchens to operating theatres. The last three units look at relationships between microbes and higher organisms, with one unit describing the interactions between different organisms and two describing microbes and human disease.

Unlike the traditional telecourse programmes that are keyed to a single textbook, *Unseen Life on Earth* will be keyed to several. Teacher and student guides will link the 12 videos with the designated introductory textbooks. The guides will identify ASM's core content theme and basic laboratory skills, recommendations on how these skills can be obtained and references to the vast array of teaching and learning materials available through ASM's Board of Education and Training. Further resources for the telecourse are planned. For more information about this and other activities of the MLC, check the website at **http://www.microbeworld.org/**.

● *Frederick K. Pfaender, University of North Carolina*
● *Amy Chang, ASM*

ASM Instructional Library

The ASM is pleased to announce its collection of online resources, the Instructional Library. It currently consists of two collections: (i) visual resources, including still images, animations, illustrations and videos, and (ii) curriculum resources, including inquiry-based classroom and laboratory activities. Spanish and Portuguese translations of materials are available and other languages will be available in the coming years. A third collection, journal articles discussing various facets of microbiology education with possible topics ranging from teaching methodologies to integration of new technologies, will be added to the Library in summer 2000. The Library is open to all users and allows resources to be downloaded and used for non-commercial educational purposes.

Submissions are sought for the Instructional Library. Review and selection are conducted every 4 months and the deadline for inclusion in the next round is 1 March 2000. Complete instructions for submission of visual and curriculum materials can be obtained by visiting the website at **http://www.asmusa.org/edusrc/library/**, calling +1 202 942 0282, or writing to the Instructional Library, Office of Education and Training, American Society for Microbiology, 1752 N Street NW, Washington, DC 200036-2804, USA.

● *Denise Steene, ASM*

Going Public

Going Public provides a forum for readers of *Microbiology Today* to pass on their experiences of communicating science to a wider audience than their fellow scientists. Contributions are always welcome.

Edinburgh International Science Festival 2000

■ SGM Public Symposium

1845, Monday 17 April 2000
Lecture Theatre, Royal Museum of Scotland
Vaccination is for Life

Effective vaccination programmes have greatly reduced, and in some cases eliminated, our risk of infection from life-threatening illnesses such as smallpox, polio and measles. Current research is exploring ways of providing vaccines to protect individuals throughout their life against a whole range of diseases. Why is vaccination important? What new developments are being made? What are the risk factors involved? How do our needs change with age? And what does the next millennium hold?

● Chairman: Dr David Elliman (Consultant in Community Child Health, St George's Hospital Medical School, Tooting)

● 1845
Chairman's introduction
The importance of vaccination

● 1900
Professor John Heckels (University of Southampton)
Meningitis

● 1930
Dr Ratko Djukanovic (University of Southampton)
Asthma vaccines

● 2000
Dr Wendy Barclay (University of Reading)
Influenza

● 2030
Round table discussion

For information on the Festival tel. 0131 530 2001 or e-mail esf@scifest.demon.co.uk

Millennium Awards

Two people closely associated with the SGM were fortunate enough to obtain UK Royal Society–British Association Millennium Awards for activities to promote science in 1999: **Liz Sockett**, Education Officer on Council and **Jane Westwell**, Administrator in the External Relations Office. The scheme is now closed.

The 'Millennium Bug' for Warwick...

...an experiment in education

Henry Tribe

The figure above shows a small-scale model representing, rather incompletely, the full-size 'Millennium Bug', a model of *Escherichia coli* magnified 2 x 10^6, being made by the author. At this magnification the molecules which make up the bacterial interior are 'seen' as tangible structures set out in a cutaway from a rod 4·6 x 1·6 m size, bordered by 'external solution' (aerobic, light blue; anaerobic, dark blue).

The author plans – barring disasters – to have the Bug ready for the Warwick Meeting in April 2000. Arrangements are in progress for its exhibition at a museum for a period thereafter. It is believed to be the biggest model bacterium in the world (Guinness World Records are interested!) and a novel contribution to microbiological education.

The author will welcome offers of prints of *E. coli* to accompany the model. An article on the Bug should have appeared in the January issue of *Biochemical Education*.

Genetics for the blind

BELOW:
A blind RNIB pupil testing prototype tactile diagrams of cells and RNA with a student helper.
PHOTO LIZ SOCKETT

Liz Sockett held a Millennium Award jointly with Norman Brown, who is the Head of Biology at the RNIB New College Worcester, a high school for pupils with visual impairments. Using the award, Norman and Liz have been involved in a variety of activities to promote the understanding of genetics by sighted and visually impaired school students. Together with student helpers from Nottingham University, where Liz is based, they have produced a practical called *Colours, colonies and clones* which uses colour mutants of photosynthetic bacteria along with DNA gel electrophoresis to teach high school students about genetics. The pack covers plasmid cloning, complementation and the idea of multi-step biosynthetic pathways encoded by multiple genes. The project is safe as it uses pond-dwelling bacteria. Norman already has experience of adapting DNA gel kits for use by sixth form students, so the whole practical is accessible to visually impaired pupils too. In its current form the practical uses transposon mutants and strains carrying plasmids, which means that it must be used, by law, at a centre registered for GM work. The practical is designed to be run in the labs of the new Millennium Science Centres (which open in 2000). A version of the practical using point mutants with colour defects is also being developed so it can be legally used in schools without GM licences.

Liz and her students have also used the Millennium Award to promote genetics in other ways. These include: a display on tactile science at the *Tomorrow's World Live* exhibition at Olympia; a talk on micro-organisms and Genetics to 200 junior school pupils at a Nottingham Cinema; a debate on gene ethics with sixth formers and the Provost from a church school; and the production, with two students, of packs on genetics and human variation, and on genetic disease for use in schools. The resources developed using the Millennium Award will continue to be used to attract pupils into studying genetics well into the 21st century.

Microbes on vacation

Teaching young children about the significance of microbes is very important, but challenging to accomplish. Here two approaches are described, both of which have proved to be successful in practice.

In the 1999 summer holidays more than 800 children in Reading explored the amazing world of microbes. This was made possible by a Royal Society and British Association Millennium Award which funded a collaborative project between Jane Westwell of the External Relations Office at SGM HQ and Reading Borough Council. The Award scheme funded science professionals to work (in their own time) with a community group to bring science to a target audience. Having seen the enraptured faces of children at SGM setWeek activities, Jane thought it would be a good idea to bring similar workshops to children who might not normally be exposed to science outside of the classroom. Reading Borough Council run excellent playschemes which are accessible to all children in the town, including the socially disadvantaged. Jane planned to employ two graduate students to travel around the playscheme sites and introduce children to microbes through a mixture of simple, safe experiments and arts activities. Play development staff at the Council, always on the look out for new ideas, welcomed the idea and offered to support two extra students. This type of project was a good candidate for funding since the target audience was too small and local to be funded by the SGM. The Society supported Jane's application by allowing her to use office facilities free of charge and to take unpaid leave to manage the project (the cost of which was reimbursed to Jane as part of the award).

THIS PAGE:
Young children learn about microbes at Reading Borough Council playschemes.
PHOTOS SGM

By May 1999, Jane heard that her proposal had been successful and the project could go ahead. The rush began to find four people with the background knowledge, communication skills and, above all, patience to deliver a set of workshops to a mixed and unpredictable audience for an exhausting five weeks. This was no easy task, mainly due to the accelerated timescale brought about by late decision-making by the award panel (the process has since been made more timely). However, eventually four volunteers were found who were brave enough to face groups of young children with a subject usually considered as hard or boring (if thought of at all).

A training session delivered by John Schollar of the NCBE and Dariel Burdass (SGM Education Assistant), to prepare the students for the trials to come, was followed by two days of further preparation at Jane's house. Activities were planned and the teams discussed how best to grab audience attention and make microbiology relevant to the children's lives. The obvious choice was to make liberal use of the 'yuck' factor and to talk about 'poo' (organisms involved in sewage treatment), 'snot', mouldy bread and microbes on the body. To counter this, 'good' microbes were emphasized and plenty of reference was made to bread, yoghurt, cheese and medicines.

Each team had a laminated set of beautiful electron and photo micrographs of suitable micro-organisms and some jolly, coloured diagrams of simplified bacterial and yeast cell structures. These formed the basis of the activities since children could copy them in drawings, make 3-D models using coloured salt dough or collages with pasta shapes and dried pulses. Jane's kitchen was reduced to chaos while specimen models, collages and handkerchief paintings were made and experiments, such as dough races, tried out.

The day of reckoning arrived and the intrepid teams set out to the first playscheme site. One team (2nd year microbiology students, Sophie and Claire) had very little experience of science communication activities so Jane accompanied them on the first day and ran the workshops so they could see what they would be dealing with. After that they were confident enough to go it alone and managed with the occasional visit and follow-up telephone call from Jane. The second team (environmental science graduates, Kathy and Emma) were able to launch straight into the project and before long were coming up with innovative ideas for extra activities that the children could enjoy alongside those originally planned.

Both teams quickly adapted to the different types of accommodation and daily structure offered by the play scheme sites (19 in total) and developed ways of keeping the attention of groups of children of widely ranging ages

and abilities, who after all were there to have fun. By the end of the five weeks both teams had several home-made thank-you cards from the children and had heard many pleas to come back to the site soon. Comments from the children included "*It was really good fun*", "*Much better than science at school*" and "*I really liked finding out about microbes*". Like any good PUS event, the workshops were evaluated by the children and not one negative comment was made. This was backed up by positive feedback received from all play development workers, despite some reservations about trying to 'teach' children during a day of play. It is fair to say that the workshops offered a novel activity which was delivered in a fun way and those children who came to more than one session did remember much of what they had learned weeks earlier. We can only hope that some of this knowledge sticks with them in the years to come.

So what did we gain from the experience? Jane got valuable experience in managing two completely different teams of workers and learned that what might seem like a good idea at the time can snowball into something really BIG! The SGM got a good set of well tried and evaluated activities for future use.

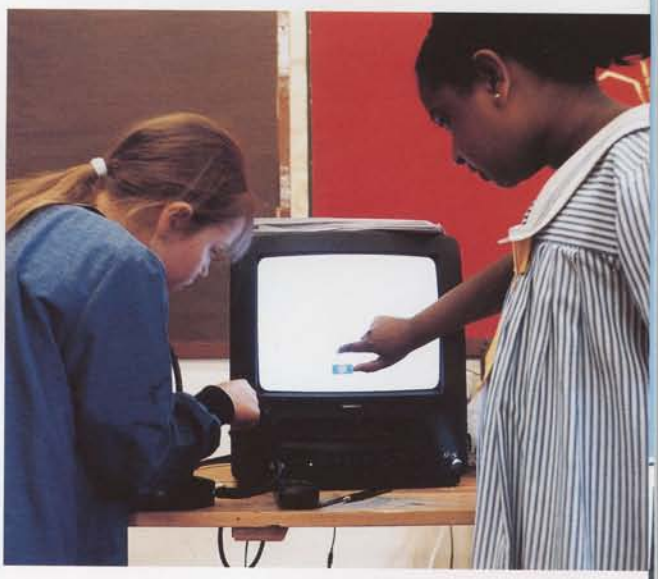
■ Further information

If you would like details of the activities for use at an event you may be planning, contact Dariel Burdass in the External Relations Office (e-mail education@sgm.ac.uk or tel. 0118 988 1835). Workshops based on the activities will also be running for two weeks as part of the children's hands-on sessions at the Edinburgh International Science Festival, if members in the North of England or Scotland would like to see them in action.

Education Development Fund report

■ Introducing microbiology in primary schools

While it is encouraging to learn, from the evidence of Standard Attainment Tests (SATs) exams, that the standard of English and Maths among UK primary school children is increasing, many are concerned that this may be at the expense of subjects which are not deemed as important in the National Curriculum. As there is the worry that elements of the science curriculum risk being marginalized, it is beneficial for university scientists to offer their local schools support in these areas where possible. In the past four years primary school children in the Swansea area have gained from a collaboration between myself at the university, supported by the BBSRC Schools' Liaison Scheme, and a local charitable organization, the Mumbles Science 2000 Centre, to offer hands-on experience in biological investigations. This year, with support from the SGM Education Development Fund, the focus has been to introduce a microbiology project. The project introduces the concepts of how ubiquitous and varied micro-organisms are, how they can be visualized either as colonies on plates or as individual cells under the microscope, the importance of personal hygiene and how we depend on some micro-organisms for valuable products like antibiotics.



ABOVE:
Swansea primary school children examine colony morphology with the aid of a flexcam, microscope and TV monitor.
PHOTO PAUL DYSON

Aimed at children at Key Stage 2, the workshop starts with a discussion on what the children understand about micro-organisms. They tend to appreciate the danger of an 'invisible' germ, be it bacterium or virus, largely based on what they have been told at home and in school. But this concept is not very tangible unless they can see for themselves exactly what micro-organisms look like and where they can be found. The concept of size is difficult to come to terms with as 'small' usually describes an object still visible to the naked eye. A useful approach, as suggested by Dr Liz Sockett (see *Microbiology Today*, Vol. 26, p. 33) is to compare a normal-sized printed full-stop with a magnified 5 m diameter 'full-stop', made of paper or material, this representing the size of a full-stop if a bacterial cell is magnified to the size of a 'Smartie'. Given their size, we explain how individual cells can only be seen using a microscope, as they will see for themselves. Alternatively, we can grow a micro-organism on a jelly so that each cell is amplified to form a colony, a mass of 10 million cells visible to the naked eye. A taxing exercise for them is to see how far they can continue doubling figures in their head, to illustrate exponential growth. We also discuss their knowledge of what micro-organisms do; cause disease is the commonest suggestion, but some know about composting and food products like yoghurt and bread. They can

ABOVE:
With the support of the SGM Education Development Fund, primary school children learn about the fascinating world of microbiology.
PHOTOS PAUL DYSON

easily latch on to the idea of 'good guys' and 'bad guys'. Just why we wash our hands, brush our teeth or clean the kitchen is often poorly understood, as it has often been instilled in them as a necessity, but poorly justified.

For the practical element of the project, the children are divided into groups and each group is provided with nutrient agar plates, one also containing ampicillin. They are given cotton-buds for use as swabs. Each group can sample the microbiological flora from a particular source. The simplest is to concentrate efforts on swabs from hands and teeth, although there is no reason with a large class, why other surfaces or media within the school or from outside cannot be tested. Working in pairs, they inoculate a quarter of a Petri dish with their swab before and after treatment with a bactericide, and also a quarter of their plate containing ampicillin. For sampling from hands or other external media and surfaces, the children swirl their cotton-bud in 'Fairy Liquid', diluted 1 : 10, as the bactericide. This kills the majority of micro-organisms on their swabs and the result is visualized by the very few colonies which subsequently arise on the agar plate. For teeth samples, they swirl their swabs in a 'fortified' mouth-wash. Commercial mouthwashes are largely ineffective as bactericides, but to emphasize the importance of oral hygiene it is important for the children to observe an effect. Hence the mouthwash is mixed with lab ethanol.

Having made sure the plates are correctly labelled, they are taken to the university for incubation. They are then sealed up individually with 'Parafilm' and placed in zip-lock freezer bags in preparation for a follow-up visit to the school. The children are instructed on the potential danger of these microbiological cultures and why, under no circumstances, should they remove the plates from their bags. They can easily screen the sealed and bagged plates and score the results, entering the data on colony numbers and variety in their notebooks. They can note the effects of the bactericide they used and the antibiotic in the medium. In general, the children are truly enthused by the results of their investigation and the evidence before them of a previously unseen world of life all about them. Moreover, it brings home quite emphatically why they should be concerned about hygiene.

This new world can be further illustrated to the whole class using a flexcam, microscope and TV monitor. To emphasize just how useful some bacteria are, the class can be shown a culture of an antibiotic-producing streptomycete. These bacteria have a particularly beautiful colony morphology and produce aerial mycelia and spores. One of the best species for demonstration purposes is *Streptomyces coelicolor* which produces two pigmented antibiotics. These features can be best shown on a TV screen using a flexcam with macro lens to magnify the plate culture. To demonstrate another way to observe bacteria, by magnification, the flexcam can be used together with an oil-immersion microscope. Using this set-up, the class can be shown single bacterial cells magnified 600-fold. One idea is to use a common *recA* lab strain of *Escherichia coli* suspended in water on the microscope slide. These cultures usually contain a mixture of rods and undivided filaments in which the septa are visible – useful for talking about how they reproduce. The children are generally fascinated by the images of animate cells 'swimming' about on the screen (in contrast to their seemingly inanimate plate colonies). They are encouraged to record pictorially what they observe – *E. coli* is easy to spell! Finally, they are given a multi-choice quiz based on what they might have learnt over the two sessions.

During this year the project was introduced at 8 primary schools and subsequently over the summer holidays at the Mumbles Science 2000 Club, reaching a total of over 500 children. It proved a big hit among pupils and teachers alike. Hopefully the success of the project will lead to a much better understanding of the microbial world among these children, and stimulate an interest among a few to learn more about the subject later on.

● **Acknowledgments**

I am grateful for the help of Andy Shercliff, Tom Hoyt, Julie Samuel and Kate Hopkinson (Mumbles Science 2000 Centre). Some of the contents of the project were inspired by similar activities devised by Professor Chris Thomas (University of Birmingham) as part of the BBSRC Schools' Liaison Network co-ordinated by Tracey Reader (BBSRC).

● ***Paul Dyson, School of Biological Sciences, University of Wales Swansea***

■ Safe practice

Anyone considering organizing microbiological investigations in schools should carry out a risk assessment first. The SGM External Relations Office is always pleased to give advice and has produced a factsheet on safety and GLP in schools.

e-mail **education@sgm.ac.uk** or download the sheet from the website: **http://www.sgm.ac.uk**

■ SGM Education Development Fund 2000

Applications are invited for the next round of awards. See website (**http://www.sgm.ac.uk**) to download a form and rules, or contact **grants@sgm.ac.uk**

International Development Fund report

LEFT:
Workshop-organizing committee outside the Department of Biotechnology, Mahidol University, Bangkok, Thailand.

BELOW:
Workshop participants.

Workshop in Thailand: Microbial Diversity and Environmental Biotechnology

■ A.G. O'Donnell, T.M. Embley & A.S. Whiteley

In an increasingly global economy, few countries escaped the impact of the Asian economic crisis. Those involved with postgraduate students from countries such as Thailand, Malaysia and Indonesia will be well aware of the problems and the worry caused to many individuals by the downturn in their home economies. In Thailand, the economic problems reverberated through all sectors of society, including the educational sector where the Royal Thai Government was forced to reduce the number of new scholarships and to limit all but essential overseas travel. For the development of microbiology and biotechnology the economic downturn came as a particular blow since prior to the crisis the Thai government had invested heavily in infrastructure, particularly in molecular biology and biotechnology.

For many countries, biotechnology and the capitalization of its natural, biological resources is often seen as an important development strategy. Over the past decade, tools borrowed from molecular genetics and the biomedical sciences have been developed for the investigation of microbial populations in natural and engineered environments. This move to incorporate molecular techniques into the study of microbial communities stemmed from the realization that conventional methodologies based on isolation and cultivation provided relatively little information about microbial community structure and function *in situ*. Recently, the extraction, amplification and cloning of rDNA and functional genes from many natural environments have become routine. These techniques of molecular ecology now offer the tools with which to study microbial communities in natural environments and as such have a key rôle in assessing the effectiveness of microbially mediated processes in natural environments and in evaluating the safety and impact of genetically modified micro-organisms (GMOs).

The use and safety of GMOs is a global issue. Understanding GMOs and their impact on the environment through gene transfer and their potential toxic effect remains a challenge for many scientists. What is known is that in natural environments, gene exchange between micro-organisms is commonplace and has given rise to a rich and diverse microflora. Microbial science has successfully exploited this diversity to deliver new drugs such as antibiotics and new industrial processes that have revolutionized our treatment of disease and made cleaner many of our important industries. Like Man, Nature also makes use of gene transfer to rid the environment of unusual chemicals such as pesticides and the by-products of industrial processes. So not all genetic exchange in nature is bad. As we enter the new millennium, growing population needs and the pressures for development make greater and greater demands on our natural resources. At the same societies have to deal with the legacies and mistakes of the past where either through greed or ignorance harm was done to the environment. Biotechnology and the management of natural processes have a key rôle to play in cleaning and protecting the environment.

For Thailand, like many countries, biodiversity, its conservation and exploitation and its relationship to environmental protection and economic and social development remain significant challenges. Microbiologists have an important rôle to play in

formulating and evaluating the effectiveness and environmental safety of microbial technologies. The workshop held at Mahidol University, Bangkok in November 1999 provided an intensive lecture and practical programme for young Thai researchers on *Microbial Diversity and Environmental Biotechnology* and the opportunity to discuss the key social and environmental issues facing microbiologists as Thailand seeks to rebuild its economy. The aim was to help facilitate a network of young staff within Thailand with interests in microbial diversity and environmental microbiology, including the impact of GMOs. The workshop was co-ordinated locally by Dr Watanalai Panbangred and was co-sponsored by BIOTEC, Thailand, and by the Society for General Microbiology through its International Development Fund. The workshop was over-subscribed, attracting over 100 applications from all over Thailand from which 80 were selected.

The workshop addressed a range of issues from the exploration of microbial diversity and the impact of GMOs through to the management of the soil's biological resources and the harnessing of these resources in the protection and clean-up of contaminated land. The practical course, run concurrently with the lecture programme, provided an introduction to DNA extraction, amplification and cloning, to sequence analysis, to the design and use of biosensors and to *in situ* bioactivity measurements. Although almost all of those attending the lecture programme wished to participate in the practicals, limited resources and our objective of providing hands-on experience meant that numbers attending the practical programme were restricted to 35. The workshop received the full support of Mahidol University and was run by Professor Tony O'Donnell, University of Newcastle, Professor Martin Embley, Natural History Museum, London and Dr Andrew Whiteley, Institute for Virology and Environmental Microbiology, Oxford.

On behalf of both the UK and the Thai participants, we wish to express our thanks to the Society for its generous and timely support. We would also like to thank all of the staff in the Department of Biotechnology for ensuring that everything ran smoothly. We are particularly grateful to the MSc students in the Department for their assistance in running the practical programme.

● *For further information about the workshop and the material discussed please contact tony.odonnell@ncl.ac.uk.*

Reviews

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

Prion Biology and Diseases. Monograph Series, Vol. 38

Edited by S.B. Prusiner
Published by Cold Spring Harbor Laboratory Press (1999)
US$125.00, pp. 710
ISBN: 0-87969-547-1

'*The saga of prions truly represents the triumph of scientific investigation over prejudice*'. Read the quote from this book. Get the message. Published as part of the prestigious Cold Spring Harbor monograph series, this post-Nobelian prionfest retells much of the story of how prions were discovered, why no one had discovered them before and how this revelation has blown away most of the mystery of mad cow disease, scrapie and the human transmissible encephalopathies. Stan Prusiner edits this monograph and contributes directly to almost half the book (327 of 794 pages), giving it a coherent, readable text illustrated by examples of his laboratory's most seminal work of the past two decades. Apart from some notable omissions, the remaining authors are drawn from the leading groups in Europe and the USA; they provide an interesting counterbalance to the prevailing style and I enjoyed browsing through their erudite, up-to-date and provocative contributions. To paraphrase Karl Popper – a good hypothesis contains the seeds of its own destruction; from that perspective I can thoroughly recommend you read this book and hope it may be your insight (or prejudice) which prevails with the Nobel Committee 20 years hence.

■ ***Jim Hope***
Institute for Animal Health, Compton Laboratory

Sexually Transmitted Diseases: Methods and Protocols. Methods in Molecular Medicine, Vol. 20

Edited by R.W. Peeling & P.F. Sparling
Published by Humana Press (1998)
US$89.50, pp. 256
ISBN: 0-89603-535-2

This is a methods book, designed to enable the practising diagnostic medical microbiologist to bring diagnostic procedures to the cutting edge of new technology. Unfortunately, a thoughtful and stimulating introduction by Fred Sparling is the only part of the book which gives any context to the methodology described. Thus for example, primer sequences are given without any indication of the genes or sequences which are the subjects for amplification. Not only does this leave the discerning reader to discover the underlying basis for the test by further research, but it may foster an indifference to the underlying concepts in the less critical practitioners of these methods. I find it difficult to conceive of tests being run and interpreted in ignorance of the molecular targets concerned. That being said, the methods are well described and generally appear robust. The book cannot aspire to be encyclopaedic within its size and price range, but would certainly be one for the shelf of every lab providing a service to STD users.

■ ***Charles Penn***
University of Birmingham

Intracellular Bacterial Vaccine Vectors: Immunology, Cell Biology, and Genetics

Edited by Y. Paterson
Published by John Wiley & Sons Ltd (1999)
£51.95, pp. 267
ISBN: 0-471-17278-2

This is a useful and very readable collection of reviews on the use of mycobacteria, listeria and salmonellae as live delivery vehicles for recombinant antigens. An introductory overview chapter on pathogenesis is followed by six others on the different vectors, with one set of authors covering mechanisms of immunity, whereas others write on the use of the organism as a delivery vehicle. The result is a well balanced volume, with the different authors drawing on their experience of either experimental or human aspects of the field. Problems in vaccine development and possible solutions are well covered in a way which makes it easy to draw analogies between the three organisms. In addition to expression of recombinant antigens themselves, the newer developments of the use of these bacteria as delivery vehicles for DNA vaccines is discussed. The book should be useful to researchers and students alike.

■ ***Carlos Hormaeche***
University of Newcastle

Electron Microscopy Methods and Protocols. Methods in Molecular Biology, Vol. 117

Edited by M.A. Nasser Hajibagheri
Published by Humana Press (1999)
US$89.50, pp. 283
ISBN: 0-89603-640-5

This ring-bound volume provides the reader with a useful source of comprehensive and accurate protocols for electron microscopic specimen preparation with an emphasis on the subcellular level. However, it should be stated that the book is not specifically tailored to the needs of microbiologists working mainly with bacterial cells. Absolute beginners will probably be overwhelmed and there is a lack of coherence leading to some confusion, e.g. the correct notion in chapter 13 that the cytochrome *c* method cannot be satisfactorily used to study the association of nucleic acids with proteins is followed by chapter 14 in which exactly this method is described for studying protein–DNA complexes. It is also not true that glow-discharging renders carbon-coated grids hydrophobic (p. 214). The

quality of the presentation of the contributions varies and a number of figures suffer from Moiré effects suggesting that the publisher could have taken greater care when producing the book.

■ ***Andreas Holzenburg***
University of Leeds

Handbook of Animal Models of Infection. Experimental Models in Antimicrobial Chemotherapy

Edited by O. Zak & M.A. Sande
Published by Academic Press Inc (1999)
US$199.95, pp. 1136
ISBN: 0-12-775390-7

Sir Alexander Fleming discovered penicillin in 1929. Yet because Fleming failed to carry out a simple animal test, first introduced in 1911, the development of penicillin was delayed by 10 years. Nearly 60 years on there is a growing need for new antimicrobial drugs, and evaluation in animal models is still an essential step prior to testing in humans. Fortunately, the chances of such an oversight occurring again are significantly reduced by this very worthwhile compendium, which updates a three-volume version of 13 years ago into a single volume work. This comprehensive book will be essential for those involved in the research and development of new antimicrobials. The first 123 pages consist of a very readable series of articles providing an introductory background to the subject. This ensures that the book will also be a valuable reference for those involved in scientific journalism and advocacy.

■ ***Kevin O'Donnell***
Scottish Agricultural Science Agency, Edinburgh

Teach Yourself Genetics

By M. Jenkins
Published by Hodder & Stoughton Educational (1998)
£7.99, pp. 172
ISBN: 0-340-70507-8

This handy sized book is directed at the general public and intended to be an introduction to genetics and the issues surrounding modern gene technology. It includes a great deal of historical background material from the discovery of cells, through to cracking the DNA code and the development of gene therapy. The author has been careful to introduce information gradually and builds upon knowledge introduced in previous sections. The snippets of history break up the 'hard science' and put it into context (also providing some welcome relief to the reader who is completely new to the subject). The author makes an excellent attempt at communicating a difficult subject to a lay audience, although it would probably help to have a degree of familiarity with biology before reading the book. This book could be very useful for the science communicator requiring a brief 'refresher' course in the subject.

■ ***Jane Westwell***
SGM, Marlborough House

Cell–Cell Signaling in Bacteria

Edited by G.M. Dunny & S.C. Winans
Published by American Society for Microbiology (1999)
£59.00, pp. 367
ISBN: 1-55581-149-3

The field of cell–cell signalling in bacteria is a rapidly expanding one that is well served by Dunny & Winans' effort. The volume presents a number of up-to-date reviews of different systems in which bacteria attract each other, for sex or to trigger differentiation, developmental or other effects such as antibiotic production. Whilst the quality of writing is excellent and must reflect careful editing, the division of the individual chapters into sections seems at best somewhat arbitrary. Virtually all of the material is concerned with quorum sensing in one form or other or cell density control of cell activities. However, this aside, it is a volume that I would personally purchase; it is informative, well referenced and has a comprehensive index. In addition to attracting the practitioners in this field, many of the chapters will be of intellectual interest, at least to those in the eukaryotic signalling community.

■ ***Paul Millner***
University of Leeds

Confocal Microscopy: Methods and Protocols. Methods in Molecular Biology, Vol. 122

Edited by S.W. Paddock
Published by Humana Press (1998)
US$99.50, pp. 464
ISBN: 0-89603-526-3

This is an excellent source for anyone who wants to explore techniques in confocal microscopy. It is a practical manual with many gems that will help both new and experienced users. The principles are efficiently and accessibly explained and there is a useful chapter on fluorescent probes. Chapter 1 contains many references to websites and the ones I tried are still functioning. The rest of the book addresses an extensive range of specialist applications. Studies on yeast cells provide the only specific microbiological content and it is disappointing that no bacteriological input was included. Nonetheless there is a wealth of ideas here waiting to be applied to prokaryotic biology and many would be equally useful for simple fluorescence rather than confocal studies. I would certainly recommend it to any lab that uses fluorescence microscopy extensively.

■ ***Mike Barer***
University of Newcastle Medical School

Pseudomonas. Biotechnology Handbooks, Vol. 10

Edited by T.C. Montie
Published by Plenum Press (1998)
US$110.00, pp. 335
ISBN: 0-306-45849-7

Whereas some books present a broad overview of the subject which is informative and sometimes provocative, others are merely vehicles for references and usually read like a telephone directory. This book is of the latter class. It covers nine aspects of *Pseudomonas* biology, only one of which is clearly biotechnological (Chapter 9, Selected industrial biotransformations) thus belying the impression one gets from its inclusion as a volume of the Biotechnology Handbook series. It also suffers from the taxonomic identity problem of recent years about what is a genuine pseudomonad. Whereas most of the chapters deal (probably correctly) with *P. aeruginosa*, and other true pseudomonads are also less fully covered, the honorary or ex-pseudomonads such as *Burkholderia* and *Ralstonia* have unjustifiably been insinuated in many other places. Purchase this book only if you require a pre-1996 reference source on the topics covered and can afford it.

■ ***Peter A. Williams***
University of Wales Bangor

The Biotechnology Directory 1999

In association with 'Nature Biotechnology'
Edited by J. Coombs & Y.R. Alston
Published by Macmillan Publishers Ltd (1998)
£179.00, pp. 917
ISBN: 0-333-68789-2

This directory is an excellent guide not only to biotechnology companies worldwide, but also to the latest commercial exploitation of research in this rapidly changing field. The book is divided into four sections: profiles of companies, universities, institutes and research organizations; a buyer's guide to products, equipment and services; sources of information; and comprehensive indexes. The list of scientific activities covers many columns, indicating the amazing diversity of modern biotechnology. If you want to know who is developing products from algae or actinomycetes or researching the applications of lectins, lignin or liposomes, this resource will provide the answers. The Activity Index lists entries by subject, but the list of companies is alphabetical within countries. Extensive cross-indexing makes the volume easy to use. Full contact details are provided for each organization, including the invaluable URL for their websites. The book also includes information on sources of research funding. All in all a useful reference tool with plenty to interest the microbiologist.

■ ***Janet Hurst***
SGM, Marlborough House

Escherichia coli O157 in Farm Animals

Edited by C.S. Stewart & H.J. Flint
Published by CABI Publishing (1999)
£45.00/US$85.00, pp. 256
ISBN: 0-85199-332-X

The Scottish outbreak of *E. coli* O157 at the end of 1996 was one of the world's most severe cases of food poisoning ever recorded. In particular, the number of fatalities (21) greatly heightened public concern about food safety. During 1998 an international workshop was held at the Rowett Research Institute in Aberdeen, where a number of leading researchers presented the latest findings on this organism. This book summarizes these high quality papers. Various aspects of the microbiology of verocytotoxigenic *E. coli* are discussed, with particular emphasis on control through the food chain. In particular there are thorough reviews on carriage in animals, acid tolerance, molecular aspects, ecological interactions, infection in humans and incidence in the slaughter house. The

writing style is clear throughout and the information is up-to-date, with many of the authors discussing new methods of detection and predictions of transmission. Because of the topical nature of this subject the book will have a wide readership, with microbiologists involved in veterinary medicine and public hygiene being the main interested parties.

■ ***Glen Gibson***
University of Reading

Bacterial Responses to pH. Novartis Foundation Symposium 221

Edited by D.J.Chadwick & G. Cardew. Chairman: R.K. Poole
Published by John Wiley & Sons Ltd (1999)
£75.00, pp. 264
ISBN: 0-471-98599-6

This book provides a useful, up-to-date compilation of information on the topic, which can otherwise only be found rather widely scattered throughout the literature over a considerable time period. The coverage is wide, not only in terms of pH range (0–14) but also in bacterial terms (archaea to rhizobia). The 14 chapters are in the form of scientific papers, well illustrated and referenced, including useful abstracts. The impact of molecular studies in explaining the physiology of microbes in response to pH is evident throughout and part of the book's value is in the clarity of the explanations provided by the authors. Another enlightened feature is the inclusion of discussions both on individual papers and a final general session which enables the non-specialist to ascertain the critical points of interest and debate in this field. Overall, a worthwhile library purchase.

■ ***Martin Collins***
The Queen's University of Belfast

Handbook of Probiotics

By Y.-K. Lee, K. Nomoto, S. Salminen & S.L. Gorbach
Published by John Wiley & Sons Ltd (1999)
£64.50, pp. 211
ISBN: 0-471-19025-X

The stated aim of this book is to put together the data and methodology required to develop a probiotic product. Certainly data packing is extremely high, reflecting the enormous volume of literature on the topic. The authors have done well to abstract, select and summarize key material and organize it into six sensibly chosen chapters. The attempt to index such a mound of information is really an impossible mission and so it proves. It is clear that the authors have tried hard but this is a weakness of the book which will unfortunately ensure that readers will need to scan the most likely chapter in search of a particular point. That said, it is rare that you get so much well abstracted information for the price making it a worthwhile purchase for all who are trying to develop or use probiotics.

■ ***Martin Collins***
The Queen's University of Belfast

The Baculoviruses. The Viruses

Edited by L.K. Miller
Published by Plenum Press (1997)
US$110.00, pp. 447
ISBN: 0-306-45641-9

Baculoviruses are often equated solely with the *Autographa californica* baculovirus expression system. But these viruses have a long and interesting history that ranges from their use as viral insecticides to their illustration of novel forms of gene regulation and interaction with the host cell. Expertly edited by Lois Miller, each chapter of this book is contributed by specialist authors and provides considerable detail for the informed reader. For the new reader chapter upon chapter builds up a graduated and eventually complete picture of current baculovirology. The gene regulation chapters back up the widespread use of baculoviruses for heterologous gene expression whilst those on the available genome sequences inform their future exploitation. The baculovirus manipulation of the apoptotic pathway of the cell is included as is a description of baculovirus expression vectors including the relatively neglected areas of protein processing and alternate promoter usage. The book provides a reference work for insect virology labs, a handbook for readers new to the field and provides excellent material for those lecturing the subject.

■ ***Ian Jones***
NERC, IVEM, Oxford

The Diversity of Living Organisms

Edited by R.S.K. Barnes
Published by Blackwell Science (1998)
£19.50, pp. 345
ISBN: 0-632-04917-0

With the aid of profuse illustration and the adoption of a modern classification structure, the book represents a valiant attempt to provide a concise description of all life on earth, from bacteria to mammals. The intention is to provide an understanding of the diversity of organisms, which in recent years has lost the weight it used to have in biology courses. The factual presentation is mostly accurate but the book falls down in the linking of the textual descriptions and illustrations. While some sections are usefully illustrated, with labelled diagrams aiding understanding of the textual descriptions, other sections provide little visual aid in the understanding of organismal structure. For example the entire chapter on plants has not a single labelled diagram and the animal material is very patchy in this regard. For this reason I believe that much of the potential audience would find this volume rather heavy going.

■ ***Colin Moore***
Heriot-Watt University, Edinburgh

I Wish I'd Made You Angry Earlier. Essays on Science, Scientists and Humanity

By M. F. Perutz
Published by Oxford University Press (1999)
£19.99, pp. 354
ISBN: 0-19-850531-0

A splendidly varied and totally readable collection of articles, some new and some previously published elsewhere, but all the better for being drawn together in one volume. Perutz explores the discoveries made by the scientific giants of the late nineteenth and twentieth centuries, set against the broad sweep of world events, and how these were influenced by the discoveries. The range is enormous: from the chemical synthesis of ammonia, nuclear fission, X-ray crystallography and microbiology, to the geriatric illusions of Nobel laureates. A number of essays deal with Perutz's own exceptional life and career, from his experiences during World War II, to his contributions to understanding protein structure and function. Others explore his concerns for a number of humanitarian issues. I enjoyed the book straight through on a long flight; it would also be ideal for dipping into. Either way, the sort of book you are sorry to finish.

■ ***Ron Fraser***
SGM, Marlborough House

Choosing and Using Statistics: A Biologist's Guide

By C. Dytham
Published by Blackwell Science (1999)
£18.50, pp. 218
ISBN: 0-86542-653-8

It is refreshing to find a handbook aimed at undergraduates and masters students in the biological sciences which does fulfil its design aim to enable those who want to process their data through a statistical package on a computer without having to understand the minutiae of how the test works and how to do the actual calculations manually. The thrust of the book is on the selection, use and inferences that can be drawn from using the appropriate statistical test. The starting point is a clear listing of eight steps to successful data analysis which rightly emphasizes the importance of experimental design. A wide range of parametric and non-parametric tests are covered using Minitab (10.51), SPSS (6.1, 7.0) and Excel (5.0) computer packages under Windows 3.11 and 95 (v2). There is clear evidence that the author has 'road-tested' the explanations. A student-affordable recommended purchase with no equations in sight!

■ ***Martin Collins***
The Queen's University of Belfast

Books Received

Microbiology: Principles and Explorations, Fourth Edition (International Edition)

By J.G. Black
Published by John Wiley & Sons Ltd (1999)
£28.50, pp. 837
ISBN: 0-471-37732-5

Brock Biology of Microorganisms, Ninth Edition

Edited by M.T. Madigan, J.M. Martinko & J. Parker
Published by Prentice Hall (2000)
US$ 74.00, pp. 991
ISBN: 0-13-081922-0

Diary

april 2000

IACR-ROTHAMSTED MILLENNIUM CONFERENCE – INTERACTIONS IN THE ROOT ENVIRONMENT – AN INTEGRATED APPROACH

IACR-Rothamsted, Harpenden, Herts, 10–12 April 2000

CONTACT: http://www.iacr.ac.uk/res/corporate/meetings/tmeetindex.html or Barbara Vernon (Tel. 01582 763133)

STRUCTURAL BIOLOGY MEETING. BIOCHEMICAL SOCIETY CONFERENCE

University of Leeds 11–13 April 2000

CONTACT: Biochemical Society (Tel. 020 7580 3481; Fax 020 7637 7626; http://www.biochemistry.org/meetings.htm; e-mail meetings@biochemistry.org)

may 2000

32ND EUROPEAN HUMAN GENETICS CONFERENCE

Amsterdam, The Netherlands 27–30 May 2000

CONTACT: Jantie de Roos, Director, ROSE International, PO Box 93260, 2509 AG The Hague, The Netherlands (Tel. +31 70 383 8901; Fax +31 70 381 8936; e-mail roseint@euronet.nl; http://www.eshg.org)

june 2000

3RD INTERNATIONAL MEETING ON THE MOLECULAR GENETICS AND PATHOGENESIS OF THE *CLOSTRIDIA*

Kazusa Academic Park, Kisarazu, Chiba, Japan 8–11 June 2000

CONTACT: Rick Titball (e-mail rtitball@dera.gov.uk) For programme details, registration and abstract submission see http://w3.ouhsc.edu/cp2000/

NEGATIVE STRAND VIRUSES 2000. ELEVENTH INTERNATIONAL CONFERENCE ON NEGATIVE STRAND VIRUSES

Québec City, Canada 24–29 June 2000

CONTACT: Negative Strand Viruses 2000, PO Box 33799, Decatur, GA 30033-799, USA (Tel. +1 404 728 0564; Fax +1 404 728 0032; e-mail nsv2000.com; http://www.nsv2000.com)

july 2000

THE AMERICAN SOCIETY FOR VIROLOGY 19TH ANNUAL SCIENTIFIC MEETING

Fort Collins, Colorado, USA 8–12 July 2000

CONTACT: Sidney E. Grossberg, Secretary-Treasurer, American Society for Virology, Department of Microbiology and Molecular Genetics, Medical College of Wisconsin, 8701 Watertown Plank Road, Milwaukee, WI53226-0509, USA (Tel. +1 414 456 8104; Fax +1 414 456 6566; e-mail segrossb@mcw.edu)

ANAEROBE 2000: A CONGRESS OF ANAEROBE SOCIETIES

Manchester Metropolitan University, Manchester 10–12 July 2000

CONTACT: *US Office* Fax +1 310 216 9274; e-mail asa@anaerobe.org; www.anaerobe.org
UK Office Fax 0161 247 6365; e-mail anaerobe2000@mmu.ac.uk; www.shef.ac.uk/ ~ sam/

GENE ACTION AND CELLULAR FUNCTION IN PARASITIC PROTOZOA

Chancellor's Conference Centre, University of Manchester 13–15 July 2000

CONTACT: Biochemical Society (Tel. 020 7580 3481; Fax 020 7637 7626; http://www.biochemistry.org/meetings.htm; e-mail meetings@biochemistry.org)

BEYOND THE GENOME: 18TH INTERNATIONAL CONGRESS OF BIOCHEMISTRY AND MOLECULAR BIOLOGY. UNDERSTANDING AND EXPLOITING MOLECULES AND CELLS IN THE THIRD MILLENNIUM

International Convention Centre Birmingham, 16–20 July 2000

CONTACT: Biochemical Society (Tel. 020 7580 3481; Fax 020 7637 7626; http://www.iubmb2000.org/meetings.htm; e-mail info@iubmb2000.org)

INNATE IMMUNITY

GlaxoWellcome, Stevenage, Hertfordshire, 21 July 2000

CONTACT: Biochemical Society (Tel. 020 7580 3481; Fax 020 7637 7626; http://www.biochemistry.org/meetings.htm; e-mail meetings@biochemistry.org)

THE AMERICAN SOCIETY FOR VIROLOGY 20TH ANNUAL SCIENTIFIC MEETING (SPONSOR: UNIVERSITY OF WISCONSIN-MADISON)

Madison, Wisconsin 21–25 July 2001

CONTACT: Sidney E. Grossberg, Secretary-Treasurer, American Society for Virology, Department of Microbiology and Molecular Genetics, Medical College of Wisconsin, 8701 Watertown Plank Road, Milwaukee, WI53226-0509, USA (Tel. +1 414 456 8104; Fax +1 414 456 6566; e-mail segrossb@mcw.edu)

51ST HARDEN CONFERENCE. FATTY ACID DESATURASES: FORM FUNCTION AND FUTURE

Wye College, Kent 30 July–2 August 2000

CONTACT: Biochemical Society (Tel. 020 7580 3481; Fax 020 7637 7626; http://www.biochemistry.org/meetings.htm; e-mail meetings@biochemistry.org)

september 2000

ACINETOBACTER 2000: 5TH INTERNATIONAL SYMPOSIUM ON THE BIOLOGY OF *ACINETOBACTER*

Noordwijkerhout, The Netherlands 3–6 September 2000

CONTACT: Dr L. Dijkshoorn, Department of Medical Microbiology, Academisch Ziekenhuis, Postbus 9600, 2300 RC Leiden, The Netherlands (Tel. +31 71 5263931; Fax +31 71 5248148; e-mail dijkshoorn@rullf2.medfac.leidenuniv.nl)

EXTREMOPHILES 2000. THE 3RD INTERNATIONAL CONGRESS ON EXTREMOPHILES

Technical University Hamburg-Harburg, Germany 3–7 September 2000

CONTACT: Ms Gerlinde Loebkens, TUHH-Technologie GmbH, Schellerdamm 4, 21079 Hamburg, Germany (Tel. +49 40 76618012; Fax +49 40 76618018; e-mail loebkens@tutech.de)

ICHC 2000

University of York 3–8 September 2000

CONTACT: Allison Winton, Publicity Officer, Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; Conference e-mail rebecca@rms.org.uk; Exhibition e-mail allison@rms.org.uk; http://www.rms.org.uk)

DANGEROUS PATHOGENS 2000. BUGS WITH ATTITUDE

University of Plymouth 4–7 September 2000

CONTACT: Les Baillie, DERA Porton Down, Salisbury SP4 0JQ, UK (Tel. 01980 613881; Fax 01980 613284; e-mail lesbaillie@hotmail.com

SIXTH EUROPEAN WORKSHOP ON VIRUS EVOLUTION AND MOLECULAR EPIDEMIOLOGY

Leuven, Belgium 4–9 September 2000

CONTACT: Anne-Mieke Vandamme, Rega Institute and University Hospitals, AIDS Reference Laboratory, Minderbroedersstraat 10–12, B-3000 Leuven, Belgium (Tel. +32 16 332180; Fax +32 16 332131; e-mail annemie.vandamme@uz.kuleuven.ac.be; http://www.kuleuven.ac.be/aidslab/veme.htm)

EUROPEAN CONFERENCE ON NUTRITIONAL ENHANCEMENT OF PLANT FOODS

John Innes Centre, Norwich 6–9 September 2000

CONTACT: Conference Secretariat, c/o IFR, Norwich Research Park, Colney, Norwich, NR4 7UA (Tel. 01603 255328; Fax 01603 255168; e-mail ifr.communications@bbsrc.ac.uk)

EUROPEAN VIROLOGY 2000

Royal Concert Hall, Glasgow 17–21 September 2000

CONTACT: InConference, 10b Broughton St Lane, Edinburgh EH1 3LY (Tel. 0131 556 9245; Fax 0131 556 9638; http://www.euro-virology.com)

EXTRACELLULAR POLYMERIC SUBSTANCES (EPS) – THE CONSTRUCTION MATERIAL OF BIOFILMS. (SPONSORED BY THE INTERNATIONAL WATER ASSOCIATION)

Mülheim, Germany 18–20 September 2000

CONTACT: Andrew Leis, Gerhard-Mercator-Universität, Fachgebiet Aquatische Mikrobiologie, Geibelstraße 41, D-47057 Duisburg, Germany (Tel. +49 208 40303 435; Fax +49 208 40303 84; e-mail leis@uni-duisburg.de)

52ND HARDEN CONFERENCE. SIGNALLING IN PLANTS

Wye College, Kent 18–22 September 2000

CONTACT: Biochemical Society (Tel. 020 7580 3481; Fax 020 7637 7626; http://www.biochemistry.org/meetings.htm; e-mail meetings@biochemistry.org)

october 2000

BIOTEC 2000:
V IBERIAN CONGRESS ON BIOTECHNOLOGY;
II IBERO-AMERICAN MEETING ON BIOTECHNOLOGY;
I BRAZILIAN CONGRESS ON BIOTECHNOLOGY

Recife, Brazil 1–4 October 2000

CONTACT: Prof. José Luiz de Lima Filho, Universidade Federal de Pernambuco, Av. Professor Moraes Rego, S/N, Cidade Universitária, CEP 50761-901, Recife, Pernambuco, Brazil (Tel. +55 81 2718484; Fax +55 81 2718485; e-mail biotec2000@lika.ufpe.br; http://www.lika.ufpe.br/BIOTEC2000)

july 2001

THE AMERICAN SOCIETY FOR VIROLOGY 20TH ANNUAL SCIENTIFIC MEETING (SPONSOR: UNIVERSITY OF WISCONSIN-MADISON)

Madison, Wisconsin 21–25 July 2001

CONTACT: Sidney E. Grossberg, Secretary-Treasurer, American Society for Virology, Department of Microbiology and Molecular Genetics, Medical College of Wisconsin, 8701 Watertown Plank Road, Milwaukee, WI53226-0509, USA (Tel. +1 414 456 8104; Fax +1 414 456 6566; e-mail segrossb@mcw.edu)

Comment

Don't 'Bett' on it

The Wellcome Trust (and some other funding Charities) have long argued that the remuneration of academic scientists is too low to retain the best minds in a sector that is the most vital for the long-term survival of our society in modern competitive environments. Most other developed nations appropriately recognize its importance. A recent analysis (The Bett Report) confirmed this assessment and recommended increases of up to 20 % for some staff over the next 3 years. Bett noted that '*academic salary rates in the pre-1992 universities had increased by some 18 % less than public sector salaries generally since 1981*'. This despite an increase in productivity averaging 6 % a year between 1991 and 1995 compared with 2 % a year in the UK service sector as a whole. The precipitate decline in take up of careers in scientific and engineering research, particularly by the most able children and students, is a blindingly obvious testimony to these assessments of the consequences of neglect by numerous governments. So far no positive decision on Bett has been made but few people are inclined to be optimistic that real changes on the scale required will emerge.

Against this background The Wellcome Trust has once again seized the initiative in unilaterally awarding a 30 % increase in salary for its own personally funded Fellows. Although highly commendable (and one hopes the Government will follow suit!), there are some difficult short-term consequences for the higher education sector when any of these fellows join the university payroll, where corresponding salaries are nearly a third less. What options, then, are open to the universities?

- Follow the standard 'wage for age' tradition and appoint at a position on the academic scale appropriate to the achievements of the fellows. In most cases, this would be somewhere at lecturer level. Unfortunately, a likely consequence is that the fellow will suffer a cut in salary for the 'privilege' of taking up an established post.

or

- Adhere to the other normal tradition of appointing at a salary that is at least equivalent to that currently 'enjoyed' by the fellow. In at least some circumstances, this will present a real problem of fairness and equivalence to colleagues since the salary will be in the senior lecturer range without the fellow having demonstrated the normal achievements in teaching, administration, grant awards and publications normally expected of a senior lecturer or reader.

For obvious reasons, neither of these options is attractive. There may, however, be a temporary but not altogether satisfactory solution. This would be to appoint at the appropriate academic point but at the same time offer a temporary supplement equivalent to the salary loss. This supplement could have a finite life span (say 3 years) or it could continue on a 'protected' basis until the substantive salary catches up. This period would allow either an enhanced pay award for academics to be granted or the fellow to achieve the status of senior lecturer/reader in the normal promotional fashion. Thus, for most people the period of the additional supplement would probably be relatively short.

Whichever option is taken, there is likely to be a perception of unfairness and inequity. Academic salary arrangements, already vulnerable to equal pay for work of equal value claims, will be further exposed. Temporary supplements, short-term contracts and uncertainty are not the basis on which to build a reward structure which will motivate and stimulate high academic performance. This is an inevitable consequence of a piecemeal approach to solving the problem of uncompetitive salaries. The fault undoubtedly lies with the unprincipled abuse of a dedicated section of the public sector by successive governments – the consequences of which are already with us as our scientific and engineering profession haemorrhages its vital talent.

Until that realisation provokes some action, we have problems, hopefully short-term, such as the one mentioned above which can be morale-sapping. Has anyone a better solution?

Professor J.B.C. Findlay, Chairman, Faculty of Biological Sciences, University of Leeds

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