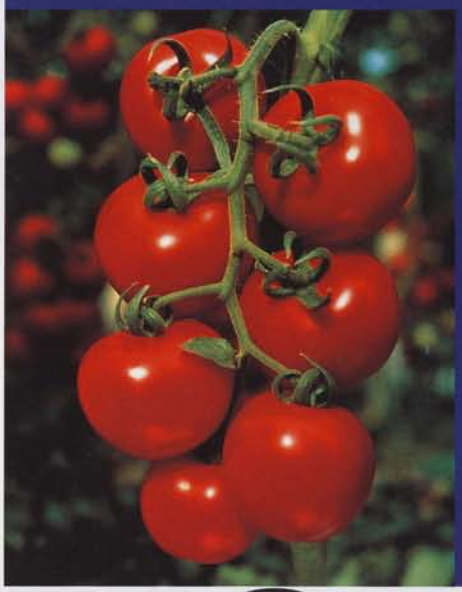

MICROBIOLOGY TODAY

QUARTERLY MAGAZINE OF THE SOCIETY FOR GENERAL MICROBIOLOGY VOLUME 26 FEBRUARY 1999

Genetically modified crops
BSE: the big issues
Quarantine and rabies
Microbial signalling and communication
Handling micro-organisms – the law

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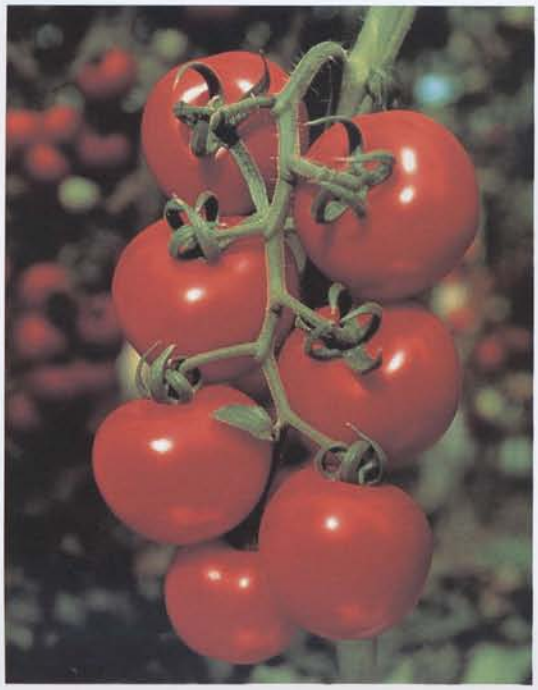


Above: Hothouse tomatoes growing in Sicily, Italy.

Can we afford to ignore the new opportunities offered by genetically modified plants? Some of the issues surrounding this controversial technology are discussed on pp. 3–7.

Photo courtesy The Image Bank.

Welcome to the first issue of *Microbiology Today*, which replaces the *SGM Quarterly* as the members' magazine of the Society. The editorial team hopes that you enjoy reading it and find that the content reflects topics of current interest in microbiology.

We also hope that the features will prove informative to non-specialist readers.

In addition to the articles, some new features have been introduced, such as 'Hot off the Press', which highlights exciting scientific developments described in papers in recent SGM journals, and a two-page spread to promote future SGM meetings.

Feedback on the new magazine is welcome, as are ideas for articles and offers to contribute material.

● ***Dave Roberts, Editor***

Articles

Regular Features

Other Items

Ethics and the microbiologist

Ray Spier

The questions 'what has ethics to do with microbiology?' or 'why should microbiologists bother with ethics?' are now firmly planted on the academic agenda. This is largely as a consequence of the emergence, over the past 25 years, of the techniques which enable us to read and engineer the genes of micro-organisms, and to produce cloned animals from cells in culture. Some have argued that these abilities rank above those of the nuclear engineer in terms of their potential to transform civilization. So it is not surprising that the way these techniques might be deployed is a matter of great concern to the wider society. It therefore behoves microbiologists to be aware of the likely impacts of their vocation which, in turn, requires that they become familiar with the ethical issues raised and possible ways by which such concerns can be treated.

Ethical issues pose questions about the appropriate behaviour required in a given situation. Answers to these questions can be derived from a 'descriptive ethics' which denotes the way different cultures respond to ethical questions, or answers can be obtained by reference to a compilation of 'normative ethics' assembled from statements about what is right behaviour or a good thing. These latter statements may be derived from a basic ethical premise such as "the end of all behaviour is happiness" (Aristotle) or "do to others what you would have others do to you" (sometimes referred to as the Golden Rule which may also be stated in its negative version) or "obey God" (the Bible). The examination of the arguments as to which basic premise to use is called 'meta-ethics'. So, when making ethical judgements, it is useful to be able to ground one's deliberations in one or other ethical system.

On examining the ethical issues facing microbiologists, it is helpful to consider them in two segments. The first centres on the way in which microbiologists work [the process (means) of doing microbiology], while the second pertains to the practical and theoretical objectives to which the work is directed [the products (ends) of microbiology].

From a consideration of the way microbiologists work and as a result of the increasing pressure placed on all academics through reviews and assessments, it has become increasingly necessary to recognize that unacceptable behaviour might result. For example, the falsification and fabrication of data coupled with the theft of data, ideas or published material (plagiarism, which could also occur when refereeing papers or reviewing grant applications) have been recognized as leading areas of scientific misconduct. Undeclared interests which could bias the selection of results is also a serious worry and many journals now require funding sources to be declared (if not always published). Other issues are raised when academics withhold information or provide misleading impressions to possible competitors. The authorship of papers and grant applications is also a source of contentious behaviour as the various parties wrestle over who has made the intellectual versus the practical contribution to the final document. Many microbiologists use animals to test vaccines or raise antibodies; it is important in such work that the minimum number of animals is used to the greatest effect while achieving as much of the toxicity work as possible in cell cultures.

In the product category, the genetic engineering of micro-organisms has roused many criticisms from which four major themes can be discerned. The first is that the genetic manipulation of a human pathogen may result in the production of a 'doomsday bug'. This is equated to the disaster personified in Frankenstein's created monster. The projection of such work to the area of biowarfare is also held in dread. However, the application of the self-same skills enable us to fabricate antidotes to existing and future pathogens as we are well on the way to achieving the total elimination of virally caused polio by the early years of the new millennium. It is also expected that measles and the range of diseases caused by *Haemophilus influenzae* b will also be eradicated. Nevertheless, the threat from a readily made biowarfare agent needs to be taken seriously and the deployment of additional resources to meet such a contingency cannot be obviated. A second view of genetic engineering is that it usurps the functions of the deity or it involves microbiologists and genetic engineers in 'playing God'. One could argue that the deity intended us to develop and use these techniques, and in any case humans no longer posture as gods. The third contention is that it is not natural for humans to deliberately alter the genomes of other organisms. We have, of course, been producing different mutant microbes by the billion over the last 50 years in seeking those cultures which produce the greatest quantities of the most efficacious antibiotics and vitamins without a trace of a suggestion that this was unethical. In this work it would be the selection process which would provide a deliberate human-determined outcome but without incurring the criticism of unnaturalness. Such a precedent may be used to counter the criticism of the efforts of the genetic engineer who seeks the same outcome but by using a method which, it is hoped, can achieve the same or similar ends in a shorter time. Fourth, some argue that as big business is alleged to be the only agency which profits from genetic engineering, the imbalance in the distribution of community wealth is exacerbated. Here the criticism is not about genetic engineering *per se*, but rather the nature of big business. As such the remedy is in the socio-economic system rather than in the Petri dishes of the microbiologist.

Specific issues pertain to a welter of microbiological products amongst which we can discern vaccines; viral vectors carrying genes for therapeutic, prophylactic or enhancement effects; animal cell cultures which can provide nuclei for the production of animal and, potentially, human clones; foods and beverages made from or with genetically modified microbes; the effect of such organisms on both the

Genetically manipulated food for thought

biological and physico-chemical environment; and a plethora of bioprocesses used to make improved detergents, digest polluting effluents, change the properties of paper pulp and provide the capability to effect stereospecific biotransformations. While only some of these activities generate serious ethical concerns, it would be salutary were microbiologists prepared to meet such issues in a prepared and measured way. In so doing, the reputation of the discipline would be enhanced with a corresponding decrease in the unease which is voiced on behalf of the community via the media. This means that ethics has to become part of the microbiologist's armamentarium of understandings and capabilities.

● *R.E. Spier is Professor of Science and Engineering Ethics in the School of Biological Sciences, University of Surrey, Guildford GU2 5XH*

Europe is currently in the midst of a heated, often emotional debate about the risks and ethics of genetically manipulated (GM) food plants. The issues are diverse: possible environmental effects from the spread of transgenes, possible consequences of the spread of antibiotic resistance genes used as selectable markers in production of transgenic plants, effects of transgenes for pest and disease resistance on evolution of the target population; whether GM food should or even can be segregated from that produced by traditional plants; whether GM food should be labelled and what information the label should contain; whether there should be a moratorium on planting GM lines while further research is done.

Some of these issues are socio-economic; some are environmental. Others are clearly scientific, and many of these are firmly within the sphere of microbiology. For example, several of the tools that are used to create transgenic plants are derived from microbes, as are some transgenes used to confer pest and disease resistance. Might genes from GM crops end up in other microbes, with undesirable consequences? It is important therefore that microbiologists bring their specialist knowledge to bear in the debate.

There are two sides to the argument about GM plants: are there unacceptable risks, and is this technology actually necessary? The following articles by Sue Mayer and John Heritage focus largely on what they see as areas of risk and uncertainty; in each case there is a need for informed argument about the science, and a value judgement about the consequences. Are the processes giving rise to the perceived risk actually likely to happen? Are the outcomes to be feared, or do they pale into insignificance against the background of the weird and wonderful things already happening in the biosphere, and in particular, already achieved by micro-organisms under their own steam? Are there beneficial consequences or objectives which outweigh the perceived threats?

In considering whether the technological advance of plant genetic engineering is actually necessary, it is important to look at a number of timescales. What is undoubtedly motivating the biotechnology companies at present is profit and the creation and expansion of market share. In the longer term, the most important factor is feeding the ever expanding human population. This has to be done while causing the minimum of damage to the planet through over-intensification, bringing yet more natural ecosystems into cultivation, and over-exploitation of resources such as fisheries.

GM plants will undoubtedly offer greater productivity and improved mechanisms of pest and disease control. The latter are of especial interest to microbiologists. At present, food production is heavily dependent on the use of chemical pesticides: it is estimated that 1.5 billion people would starve if none were used. But these existing controls are fragile: pesticides are based on a very small number of groups of compounds, and are countered by development of resistance in the target species on all too many occasions. Can we afford to ignore the new opportunities offered by GM plants for expansion of the pest control armoury, often with environmentally beneficial side effects?

● **If you have views on these issues, and those raised in the accompanying articles, why not write to the Editor of *Microbiology Today*.**

COURTESY THE IMAGE BANK

One swallow does not a summer make

John Heritage

A microbiological look at genetically modified crops.

A storm over the introduction and use of genetically modified crops has been growing over recent months. The public debate, as with many controversial scientific topics, has been unenlightening and much disinformation has been promulgated by interested parties on both sides. A recent series of *New Scientist* articles provided a more balanced forum for the opposing views but they came to no clear conclusions. Public opinion polls suggest the 'Great British Public' wants nothing to do with 'Frankenstein farming'; yet the same 'Great British Public' is happy to buy genetically modified tomatoes, clearly labelled as such, by the tinful.

The public concerns over transgenic crops as food is interesting. We have been exploiting biotechnology products in human medicine for a number of years and there has been little objection to their use. For example, most insulin-dependent diabetics are happy to use cloned human insulin. There has, however, been no public outrage over the applications of biotechnology to human medicine equivalent to that seen with proposals for transgenic crops.

In a similar vein, it is interesting that people have no qualms about eating vegetarian cheddar cheese. Traditional cheese production requires the use of rennin obtained from the stomachs of calves to clot the milk in the early stages. The gene required for the production of rennin has been cloned and expressed in bacteria. Many people who have objections to the use of animal rennin will happily eat cheese that is made with the equivalent protein when produced by bacteria.

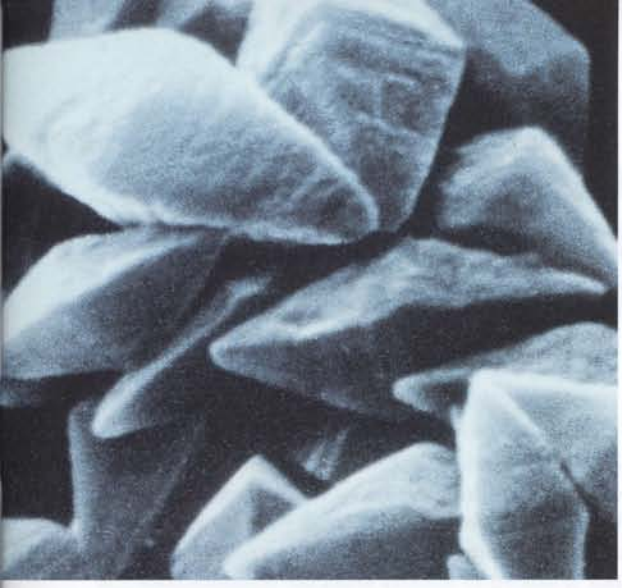
Genetically modified crops are, however, a different matter. The public does seem to view these with a degree of suspicion. Perhaps it is the nature of the crops that are currently being developed. Were a biotechnology company to produce a peanut that failed to elicit an anaphylactic reaction in those people who are allergic to nuts, the public might see this as having a real benefit, albeit for a minority of the population. The commonest genetically modified crops growing worldwide at present do not, on the face of things, seem so altruistic. Most are engineered to be resistant to herbicides. Furthermore, they are resistant to herbicides made by the companies who engineered the resistance determinants into the crops. This is an easy criticism to make of the biotechnologists but the situation is actually more complex. By engineering resistance to herbicides into crops, total herbicide usage can be reduced and a move towards more environmentally friendly chemicals can be encouraged. Issues are not clearly black and white when dealing with genetically modified crops.

Genetically modified tomato plants.
COURTESY R.S.S. FRASER

The biotechnological interests in agriculture are big business indeed. There are currently enough genetically modified plants growing around the world to cover an area the size of Great Britain. Most of these are resistant to herbicides, but crops engineered to be resistant to insect attack, if collected together, would currently cover an acreage the size of Scotland. Crops such as maize and cotton, used for oil production, have been engineered to express one of the Bt toxins produced by *Bacillus thuringiensis*. The advantages of the use of such crops are that these toxins have existed since time immemorial without selecting high levels of resistance amongst insects and without apparent toxic effects for humans. In contrast, chemical insecticides are potentially toxic to humans and are plagued by the relatively easy selection of populations of insects that are resistant to them.

Other benefits of crops that produce their own insecticides may be less tangible. Many plant infections are spread by insect vectors. By controlling the spread of vectors we can hope to control the spread of disease and of food spoilage organisms. Can we look forward to a time when mycotoxicoses are a thing of the past? Bt-producing plants may help achieve this goal. Unfortunately, however, there are early indications that the use of Bt crops may not be as successful as hoped. The sheer scale of the growth of Bt-producing plants increases very significantly the selection pressure for resistance amongst the target insects; there are suggestions from the United States that resistant insects may be emerging.

This, perhaps, should not come as a shock. We have already witnessed a similar problem with the introduction of antibiotics into clinical use. We know that antibiotic resistance genes pre-date the first use of antibiotics to treat infections but were rarely encountered. It did not take long, however, for antibiotic resistance to become apparent in hospitals once antibiotics came into use in clinical practice. As the use of antibiotics increased, so did the problem of antibiotic resistance until we have reached a stage where some infections may be untreatable, being resistant to all the antimicrobial agents currently available.



LEFT:
Crystals of *Bacillus thuringiensis* toxin.
COURTESY HRI

BELOW:
An example of a supermarket product manufactured using a genetically modified crop.
COURTESY ZENECA PLANT SCIENCE

Antibiotic resistance genes are now not confined to microbes. In the construction of transgenic plants, biotechnologists employ bacterial cells for much of the early manipulation of the transgenic material. In so doing, they take advantage of numerous bacterial cloning vectors. These often exploit antibiotic resistance selectable markers and these markers do end up in the transgenic crops. The commonest encodes resistance to kanamycin due to the expression of the *nptII* gene but several other resistance markers have been used in transgene constructs.

The use of kanamycin resistance is now widely accepted: scientists disagree with the wisdom of using other markers. These include genes that confer resistance to drugs such as streptomycin and chloramphenicol. These are drugs that are rarely used these days, at least in the developed world. When they are used, however, they are employed to treat potentially life-threatening infections. In my opinion, any measure that increases the potential for the spread of these genes to serious human pathogens ought to be resisted until the benefits can be demonstrated to outweigh the potential risks. The FDA in the United States takes a much more lenient approach to the use of marker genes (see http://vm.cfsan.fda.gov/~dms/opa-armg.html).

More worrying than the use of streptomycin and chloramphenicol resistance marker genes is the exploitation of the gene encoding TEM-1 β-lactamase. This gene is commonly found in gut microbes, it is true. Indeed more than half of urinary coliforms are resistant to ampicillin because they produce this enzyme. I do not regard this as a reason why we should permit its use in transgenic plants. My concerns over the use of this marker in transgenic plants are threefold.

First, when DNA is introduced into a new genetic background, it may undergo subtle changes, more closely matching the G+C ratio of the inserted DNA to that of its new host cell. In bacteria, the TEM-1 β-lactamase has shown itself to be exquisitely amenable to such mutations. These mutations have a disastrous effect on humanity. Many change the spectrum of activity of the enzyme from a penicillinase to an extended-spectrum β-lactamase, capable of inactivating third-generation cephalosporins such as cefotaxime and ceftazidime. Other mutations render the enzyme insusceptible to β-lactamase inhibitors such as clavulanic acid. At the latest count, there were almost 70 mutations in bacteria extending the activity of the TEM family of β-lactamases (see http://www.lahey.org/studies/webt.htm). Were such mutated genes to develop in transgenic plants, and were they to find their way from plants back into the microbial gene pool, the consequences could be grave.

Second, I am concerned that the processing of genetically modified foods permits novel opportunities for human pathogens to encounter resistance genes. If a plant containing a β-lactamase gene is dry milled, for example, this will generate significant quantities of dust. This dust will be released into the atmosphere where it will be inhaled. Many bacteria in the respiratory flora, in contrast to the intestinal flora, are naturally competent. That is, they can take up and express naked DNA from their environment. What if *Neisseria meningitidis* were to acquire TEM-1 in this fashion? Or worse, what if it were to acquire a gene that encoded a mutated TEM with extended-spectrum β-lactamase activity? We would then have written off the first line of therapy for meningococcal meningitis.

Third, I am concerned about the scale of the release of resistance genes. The biomass of resistance genes growing in plants is greater than anything that we have seen on the planet to date. This problem has already been alluded to in discussing Bt-expressing plants. The rare possibility of transfer events will be much more likely if we produce sufficient resistance genes to cover the United Kingdom. In the past we have made assumptions about the behaviour of populations based upon our current knowledge. We have not, however, seen the amplification of resistance genes on this scale before and we should proceed with caution. Recent work has shown that, under laboratory conditions, acinetobacters are capable of taking up and integrating resistance genes from transgenic plants. We should not place too much reliance on scientists who say that DNA is short-lived outside of cells and that the acquisition and expression of resistance genes by human pathogens is unlikely. In undertaking risk assessment, the scale of the operation being examined cannot be ignored.

The way forward, in my opinion, is to recognize that biotechnology holds out the promise of great advances. We should not, however, surge ahead with these advances without being aware of the risks that also accompany the application of this technology. Careful consideration of each case on its merits by competent scientists from a variety of disciplines is required. The ethical considerations of cases must also not be ignored. Within the EU framework, the Advisory Committee on Novel Foods and Processes is the designated 'Competent Body' that undertakes this task within the UK. It considers applications for each genetically modified food using expert opinion from a range of scientific and other experts. If we approach this new technology with caution, then our first swallows of genetically modified foods need not be gulps.

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Further reading

Living in a GM world. *New Scientist* 31 October 1998.

Predicting the effects of genetically modified organisms – more questions than answers

Sue Mayer

Frankenstein foods or a more sophisticated and scientific approach to feeding the world? Genetically modified (GM) crops and foods have become one of the main issues of the late 1990s, but are the critics scaremongering or the industry being complacent? The possible effects of releasing genetically modified organisms (GMOs) into the environment include those directly associated with the GMO itself, secondary effects on agricultural or other practices and socio-economic impacts, but how serious are they?

The potential for direct effects is related to the behaviour of the GMO in the environment and the particular genes which have been transferred. In the case of GM crops, if related wild plants are growing nearby, there could be cross pollination and transfer of the foreign genes into native flora. The likelihood of this depends on a host of factors, including the fertility of any hybrids formed, the relative position of the weeds and crop, and how agricultural practices affect the outcome. Since one species of weed will not be homogeneous across the UK, the likelihood of hybrid formation may even vary within a species. Thus predicting the likelihood of foreign gene flow (dubbed 'genetic pollution') is extremely complex and present knowledge remains uncertain. For crops such as sugar beet and oilseed rape, which evolved in Europe, related weeds do co-exist, have similar flowering periods and are compatible with the crop to varying degrees, so gene flow seems inevitable.

This raises the inevitable question about whether gene flow matters. Some argue that gene flow from traditionally bred crops to native flora must have been taking place for a long time with no obvious ill-effects in the UK, so why worry. However, GM crops are being altered in ways which are not possible by conventional breeding or by using techniques such as mutagenesis or irradiation, so GM-specific assessments are justified. For example, using single gene transfers (usually together with promoter and suppressor genes) crops can be made resistant to a herbicide which previously killed them, can produce a toxin which kills insect pests or resist a viral disease. If these genes are transferred into wild, weedy species under the right conditions they could give a considerable competitive advantage. One mechanism of GM disease resistance against virus diseases uses the coat protein gene of the virus itself to promote resistance by a mechanism which is not entirely understood. This is very different from conventional methods of breeding disease-resistant cultivars and, as well as wild plants acquiring a new form of resistance, there could be recombination between the transferred genes and infecting viruses leading to the emergence of new viral strains.

So gene flow may matter a lot in practical terms. However, our present understanding is so limited that accurate prediction is probably a long way off. Of course gene flow effects may not be seen for decades and become a problem inherited by our children and grandchildren.

It is not only the genes of commercial interest that may cause adverse effects. For example, the industry has been cavalier in its use of antibiotic resistance marker genes. Because the actual genetic modification technique is random and only successful in a limited number of cases, a test is needed to identify when the transformation has been successful. Therefore, an antibiotic resistance gene is generally included in the genetic material to be transferred and following treatment the cells are grown in medium containing the relevant antibiotic so only those cells where gene transfer has taken place will survive. Resistance to neomycin/kanamycin is one of the most commonly used markers, but the first commercially grown GM crop in Europe is a maize variety containing an ampicillin resistance gene as well as insect and herbicide resistance. This has raised considerable controversy because of the clinical importance of ampicillin and the risk of the antibiotic resistance gene being transferred to the bacterial flora in the intestines of animals eating the maize (which is intended for animal feed production) or in the soil. This resistance could eventually be transferred to human or animal pathogens, increasing clinical problems with antibiotic resistance. The antibiotic resistance gene plays no role in the final crop. Techniques exist to remove such unwanted genes although they increase the time and costs involved.

A recent survey by the journal *Antibiotics and Chemotherapy* revealed that 57 % of the readership who responded believed that the risk was unacceptable and the transgenic maize should be banned until the resistance gene is removed. A further 34 % considered that the risk was low but finite and that more work should be done before the maize is cleared for approval.

Despite concerns such as this, in 1998 the maize was grown on around 16,000 ha in Spain, probably about 3.5 % of the total crop, and 1,200 ha in France. It has been mixed with conventionally grown maize and is now untraceable. Undoubtedly commerce will be hoping areas will increase in future in the same way that GM crops have taken off in the USA and elsewhere. Globally (excluding China) there has been a 15-fold increase in the area of transgenic crops from 1.7 m ha in 1996, 11.0 m ha in 1997 and 27.8 m ha in 1998. It is against this background of exponential growth in the industry that the dangers have to be seen – the speed of introduction of this technology is staggering.

Other genetic material may also have unwanted effects. Although most risk assessment focuses on the gene causing the desired effect (such as disease or herbicide resistance), promoter and suppressor genes may behave unexpectedly. One common source of such genes is the cauliflower mosaic

COURTESY I. ATHERTON

virus (CaMV). Studies looking at plant viral disease pathogenesis have shown that when transgenic brassicas containing CaMV sequences as suppressors or promoters are infected with CaMV, the functional transgene (such as herbicide resistance) may be switched off, presumably as a result of co-suppression following recognition of the homologous gene sequence. This is not just of research interest – commercial varieties of herbicide-resistant oilseed rape (a brassica) containing CaMV sequences are in the final stages of approval without the potential for crop failure (as a result of gene suppression) should a CaMV virus infection arise having been considered.

Concerns have also been raised about the potential for harmful effects arising as a result of the vectors that are used to transfer genetic material. In broad-leaved dicot crops the ability of *Agrobacterium tumefaciens* to transfer genetic material into the genome of the affected cell has been adapted for use in genetic engineering. Other vectors have been developed from bacteria and viruses to transform other bacteria, viruses and animal cells in many laboratories worldwide. How might the distribution of genetic material which facilitates gene transfer affect organisms? The likelihood that an organism may acquire characteristics which increase pathogenicity or alter host range could be increased. There has been little serious investigation of such risks, even though the outcome could be extremely serious.

The GMO may also behave unexpectedly in the environment. A GM disease or herbicide-resistant crop could become a troublesome weed in the right conditions. Crops are often weeds anyway, for example when seed is shed at harvest and it germinates and emerges in the following season or seasons. If these so-called 'volunteer weeds' were herbicide-resistant, farmers' weed control options may be made more difficult. This may be especially true for farmers who have fields of non-GM crops bordering those where a GM crop is grown. Pollen from oilseed rape can travel well over 1 km and thus cross-fertilization could result in a non-GM crop being partially pollinated by a GM crop. Completely unexpected herbicide resistant volunteer weeds could be the result. Organic farmers wanting to produce a GM-free crop will face similar problems if GM crops are grown close by.

The problem with all the direct risks is that the safety regulations rely completely on a case-by-case, step-by-step evaluation. The step-by-step approach takes testing from the laboratory to the greenhouse to small and then larger field trials. The assumption is that at each stage any adverse effects will be identified and only if it is safe will the containment be reduced. The difficulties are that each trial is contained, so that adverse effects will not be seen; most of the trials are looking at agronomic, not environmental, impacts and are small-scale and short-term. As well as having limited predictive capacity, each crop is assessed individually, neglecting the potential for cumulative effects. Thus considerable uncertainty remains even after supposedly rigorous safety testing.

For secondary effects on agricultural practice the situation is even worse. Little or no notice has been taken as to whether the introduction of GM crops will potentiate the effects of intensive agriculture. English Nature and the Royal Society for the Protection of Birds (RSPB) have called for a moratorium on the commercial use of GM crops until their potential impacts on biodiversity have been considered in more detail. The use of crops resistant to broad-spectrum herbicides could alter weed flora and remove important food sources for birds already under pressure from conventional agricultural systems. Insect-resistant crops, where the toxin is expressed throughout the life of the crop, could harm non-targeted beneficial insects ingesting pests which have fed on the crop. If many different crops are modified in this way, the effects on the food web could be very serious. There are few data on these aspects.

Socio-economic impacts have received even less official attention. The presumption behind policy is that GMOs are good for competitiveness, jobs and agriculture. If the US are doing it, so must we. However, whether jobs will be created is questionable – more 'efficient' intensive agriculture has been paralleled by job losses, not gains. The biotechnology industry will also be replacing traditional crop breeders. Public opinion shows there is a healthy market for non-GM foods which will have to go outside Europe to be met if GM crops are grown here. Again there remain more questions than answers.

Considerable uncertainty remains around all the possible impacts of GMOs. People are right to be asking questions and demanding a say in whether risks are justified or not. But to evaluate the potential impacts takes time. With a technology having such a broad spectrum of possible effects, an integrated approach needs to be developed. Our present approach cannot deal with such complexities and before embarking on wholesale adoption of the technology with its irreversible consequences we need to take a break, have a moratorium, look more deeply at the issues and develop the systems to cope with them. Now is the time to do that before it's too late.

● *Dr Sue Mayer is Director of GeneWatch, an independent organization concerned with the ethics and risks of genetic engineering.*
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COURTESY THE IMAGE BANK

Further reading

Pechere, J.-C. (1998). Concerns about the presence of a β-lactamase gene in a transgenic maize. *Newsl Int Soc Chemother* Dec, 16.

BSE: the big issues

John Pattison

The government inquiry to establish and review the history of the emergence and identification of BSE and new variant CJD in the UK ran through most of 1998. The report is due in June. SEAC has an important and difficult role in advising the government on all matters relating to TSEs. Here Sir John Pattison, current Chairman, gives a personal view of the major issues that have confronted SEAC over the past few years.

The UK Spongiform Encephalopathy Advisory Committee (SEAC) was created in 1990. I did not join until January 1995, but in every one of the 36 meetings since then it has struck me that there have been one or two big issues to discuss. Although some issues are discussed over and over again, the prominence of others has changed over time. It is interesting and instructive to reflect on the nature of the big issues over the last 4 years.

CJD in farm workers

The first meeting that I attended, on 13 January 1995, when David Tyrrell was the Chairman, was a special one convened to discuss the death of a dairy farm worker from suspected CJD. This was the third case of CJD in someone working with a herd of dairy cattle in which BSE had been confirmed. Later in the year (4 October 1995) another meeting was called to discuss the significance of a fourth case of CJD in a cattle farmer with BSE in his herd. The chances of finding, between 1990 and 1996, four cases of CJD in farmers who had BSE in their herds was calculated to be about 1 in 10,000. This was worrying but we noted that there was a similar incidence of CJD in farmers, including dairy farmers, in countries with no or very few cases of BSE and that the clinical and pathological details of the cases were the same as classical sporadic CJD. The committee emphasized the need for continued surveillance and for the inclusion of material from the farmers in the strain-typing studies in the Neuropathogenesis Unit at Edinburgh. Now, 4 years later, we know that these cases in farmers have the molecular and biological features of classical sporadic CJD.

Transmission via bovine tissues

My first meeting as Chairman took place in November 1995. In the months prior to that meeting evidence had been accumulating that the level of compliance with the SBO (Specified Bovine Offals) regulations was unsatisfactory. It appeared that small pieces of spinal cord might be left in as many as 1 in 200 inspected carcasses and this was unacceptable. The SBO regulations had come into force initially in 1989 and they represented the main measure for the protection of public health. This was exactly the right public health measure to introduce and over the years the extent of the measure was repeatedly reinforced. This occurred when additional tissues (such as terminal ileum) were found to harbour the transmissible agent; we felt late in 1995 that we had to recommend a ban on the production of mechanically recovered meat from bovine vertebral column so as to ensure that no bovine spinal cord entered the human food chain; the inspections of compliance with the regulations were intensified from 1995 onwards; finally the sale of beef-on-the-bone was prohibited in 1997 when infectivity was found in the dorsal root ganglia.

New variant CJD

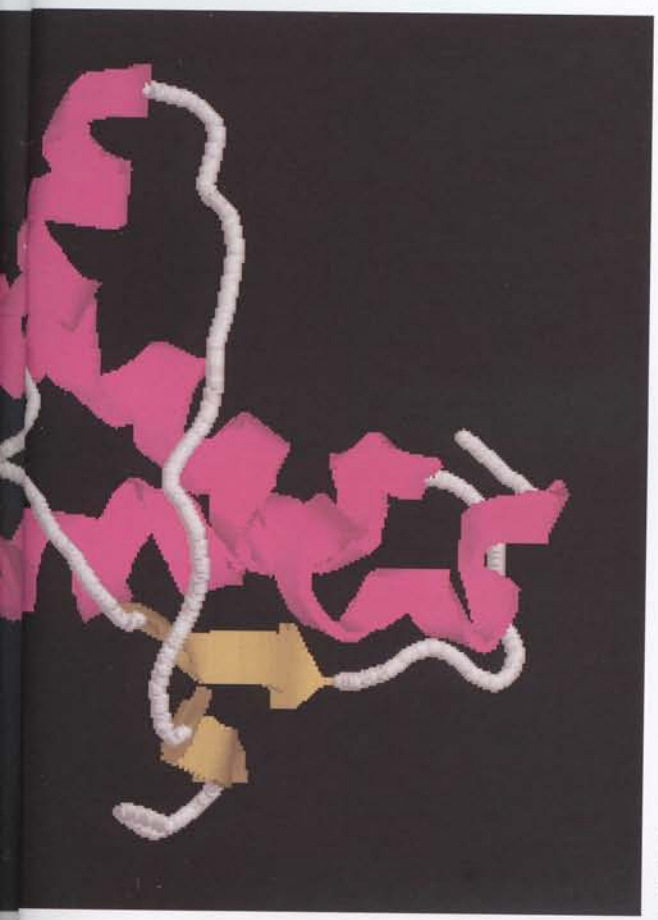
The next big issue was new variant CJD (nvCJD). Slowly during 1995 and then rapidly at the beginning of 1996, confirmed and suspect cases of CJD in relatively young people were accumulating. At our meeting of 8 March 1996, Bob Will and James Ironside from the CJD Surveillance Unit reviewed the clinical and pathological details of eight cases. They were of the opinion that the young cases in the UK with their unique pathology and similar clinical features could be a new form of CJD. Members of the committee agreed with this and believed the findings supported the possibility of a new risk factor for CJD which might be exposure to BSE. Before coming to this conclusion though, we asked James to show the pathology to other neuropathologists and Bob to have further discussions with colleagues abroad to make sure that such cases had not been seen in other countries. We met a week later to confirm our conclusions and in the statement to ministers we included the sentence:

> *On current data and in the absence of any credible alternative the most likely explanation at present is that these cases are linked to exposure to BSE before the introduction of the SBO ban in 1989.*

Much of the rest is well known and the big issues tended to be framed as questions. One question that was immediately asked was "Is there really a link between BSE and nvCJD?" The evidence for this was slow in coming because of the nature of the approaches to strain-typing. However, over the next 12–18 months it became clear that the molecular PrP^{res} type of nvCJD was different from other forms of CJD and indistinguishable from BSE and Feline SE (FSE). Moreover, the incubation period and lesion profile of infectivity from nvCJD cases in inbred strains of mice was once again different from sporadic CJD and the same as FSE and BSE.

Transmission between species

The next question that was asked was "How was the disease transmitted to humans?" Our hypothesis has always been that it was likely to be exposure to bovine nervous system tissues in beef products prior to the specified bovine offals ban, but it is hard to gather evidence to support this. There is a pleasing unity about the concept that the cattle epidemic was fuelled by the ingestion of contaminated feed:



LEFT:
Computer model of a prion protein.
COURTESY JIM HOPE, INSTITUTE FOR ANIMAL HEALTH, COMPTON

that this feed was also responsible for infecting exotic antelopes in zoos; that domestic cats were infected by the inclusion of bovine brain and spinal cord tissue in pet food; that wild cats in zoos were infected through eating carcasses of BSE-affected animals which contained spinal cord and that humans were also infected by the oral route. We think it likely that brain and spinal cord were included in the human food chain prior to the offals ban and that this is the most likely source of contaminated bovine tissue. Nevertheless, we regularly consider issues related to gelatin, tallow, milk, ox blood and the destination of various effluents from rendering plants. We also recognize that it is important not to concentrate our thinking entirely upon bovine tissues and this brings us inevitably to sheep. The Committee started thinking about this issue early in 1996, made a long statement later that year, another one in 1997 and again in July 1998. It was surprising to see the media reaction to the most recent statement, bearing in mind that nothing had changed over the last 2–2½ years. The issue is straightforward. Sheep can be infected experimentally by the oral route with less than 1 gram of BSE brain. Some sheep in the UK were fed significant amounts of MBM-containing feed and it would be surprising if some of them were not infected in the past. In the experimentally infected sheep the BSE agent can be recovered from the spleen in contrast to the situation in cattle. Thus BSE in sheep has at least one property different from BSE in cattle and similar to scrapie in sheep and it might therefore acquire other scrapie-like properties, one of which is to sustain the agent in the flock once it is there. Thus it is possible to sustain a theoretical argument that BSE might be present currently in some sheep in the UK. If you ask the question "Is there any evidence of this?", the answer is no. But, if you ask the question "Has the national flock been adequately surveyed for this?", then the answer is also no. So the only logical thing to do is to conduct an expanded programme of research into scrapie, the disease and the nature of the strains causing current cases. It will take some time to accumulate the necessary data and in the meantime the UK and Europe are pursuing a risk reduction strategy by banning the easily accessible risky material from sheep, namely brain, spinal cord and spleen.

The future

The third question that has been asked since March 1996 is "How many cases of nvCJD will there be?" Following the March 1996 announcement the answer to that question had to be a very broad range from no more cases than had already been observed, to a large six- or seven-figure number. To date there have been 3 patients who died of nvCJD in 1995, 10 in 1996, 10 in 1997 and 12 in 1998. The continuing uncertainty about the relative sensitivity of the human population, the patterns of exposure to BSE and the average incubation period of nvCJD means that a very wide range of total epidemic sizes is still compatible with the observed annual incidence to date. This therefore remains the biggest issue of all and one that will not be resolved quickly. The reason it is so important is that an ability to narrow the range and determine whether it is relatively high or low would be very helpful in many of the policy decisions that have to be taken. The emphasis is now shifting away from possible exposure of the UK population to BSE through beef products to the possibility of human-to-human transmission via medical or surgical procedures. As precautionary measures in the face of uncertainty some plasma products are derived from non-UK sources, leucodepletion of blood for transfusion is being introduced and the cleaning and sterilization of surgical instruments is under consideration.

1999 will be another important year in relation to BSE and related diseases. The epidemic in cattle is expected to continue to decline rapidly. However, big issues remain and it will be some years yet before we know the full consequences of BSE. In the middle of the year we will have the report of the Public Inquiry into BSE and we will have a judgement about whether or not we could have handled the issues better.

● *Professor Sir John Pattison is Chairman of SEAC and Vice-Provost, University College London, Gower Street, London WC1E 6BT*
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Quarantine and rabies

Ulrich Desselberger

In 1997 the Ministry of Agriculture, Fisheries and Food (MAFF) set up an Advisory Group on Quarantine [AGQ(Rabies)] to assess the risk of the introduction of rabies into the UK under the current policy of quarantine and alternatives.

Rabies is a viral infection of many mammals. It is transmitted to man in saliva through the bite of a rabid animal, travelling from the site of entry along peripheral nerve axons to invade the central nervous system. The disease, often starting with hydrophobia, develops into a disseminated encephalitis and is always fatal. In Asia, Africa and Latin America rabies is common in wildlife and is also often found in domestic animals. It is rare in most parts of Western Europe, where it is mainly carried by foxes. Vaccination campaigns have had a major impact in limiting the spread of wild-type rabies virus. In North America, where rabies is still endemic in wildlife, the likelihood of human exposure has greatly decreased. There is no animal rabies in the UK and the very rare human cases of rabies in the British Isles have always been acquired outside.

The options

The AGQ(Rabies) was asked to assess the following options.

1. Maintain the existing policy whereby imported animals are housed in quarantine facilities for 6 months.
2. Reduce the length of time animals are required to spend in quarantine.
3. Allow animals into the country from EU member states or rabies-free countries when reliable assurances can be obtained relating to identification, vaccination, blood test certification and with a system of checks after entry. Those checks could be made either (a) at the point of entry or (b) away from the point of entry in accredited reception centres. Where such assurance cannot be made, animals would be quarantined as at present.
4. Give up quarantine altogether but ensure that (a) imported animals would be subjected to pre-entry vaccination and (b) all domestic cats and dogs would be vaccinated. Were the disease to be introduced, livestock and foxes in infected areas would be vaccinated.

The Working Group, chaired by Dr Ian Kennedy, Professor of Health Law, Ethics and Policy at the School of Public Policy, University College London, deliberated extensively and consulted a large number of people. The Group's paper, *The Quarantine Report* (1), was published in September 1998. A new system of quarantine was proposed which is a version of option 3. The overwhelming concern was that any new policy should ***not increase*** the risk of introducing rabies to this country.

The new proposals

- Abandon the requirement for 6 months quarantine on entry to the UK for dogs and cats travelling from EEA countries (the 15 EU states plus Iceland, Liechtenstein and Norway). The following would be required instead: (a) identify animals electronically using implanted microchips; (b) vaccinate against rabies at or above 3 months of age; (c) identify vaccination success by blood tests; (d) treat 24 hours before entry with anthelmintic drugs and against ticks.
- Maintain 6 months quarantine for animals from countries other than qualifying countries.
- Set up a reference laboratory and accredit laboratories for testing.
- Establish a database.
- Introduce the new system after the infrastructure is in place and allow 3 years for introduction.
- Monitor the new system.
- Discontinue the system of rabies quarantine for non-carnivores from qualifying countries.
- Carry out research and establish methods to distinguish rabies-infected from vaccinated animals.
- Ensure an extensive public debate.

The arguments in favour of change

- The time is ripe for re-evaluation of the risk posed by rabies in Europe and Great Britain (2).
- EU law and policies relating to the Single Market guarantee free movement of goods and people within the EU; Britain should conform to obligations under the Treaty of Rome.
- Effective rabies vaccines are available.
- Control of rabies in wildlife reservoirs in Europe has been successful.
- Vaccination success can be checked.
- Technological advance allows safe identification of animals.
- Animal welfare groups request a reduction of stress in animals; there will also be reduction of stress in animal owners.
- Incentives for smuggling will be reduced.
- Costs to animal owners and the State will be significantly reduced.

The arguments against the proposals

- The present system has served the UK well.
- The certification of imported animals might not be trustworthy.
- An antibody assay safely indicating the protection of animals from rabies still has to be agreed upon.
- The resources needed at ports of entry to handle an increased number of animal imports per day are substantial, do not exist at present and may incur a significant cost.
- The introduction period must be longer than the anticipated 3 years.
- The number of enquiries about dog bites might increase astronomically under the new system and may not be manageable with the present resources.

The Kennedy report (1) is at present out for consultation. The Government is, in principle, sympathetic to change along the lines recommended by the Advisory Group, provided the practical means of achieving this can be found. It is appreciated that controls against rabies are a matter of concern to many people and organizations. The consultation period closes early in 1999, after which the Government will reach a decision on change. It is my opinion that the time is ripe for change and that the advantages of changing to a system as outlined above, instituted stepwise with all due care and caution, outweigh the counter arguments.

● *Dr Ulrich Desselberger of the Public Health Labs, Cambridge and Oxford, is a member of SGM Council*

Further reading

1. *The Quarantine Report* (PB 3986, £15.00 plus £1.50 p&p) is available from MAFF Publications, Admail 6000, London SW1A 2XX (Tel. 0645 556000).
2. EC Scientific Veterinary Committee, 1992 and 1997; House of Commons Agriculture Select Committee, 1994; BMA Guide on Rabies, 1995; RSPCA Report on Quarantine & Rabies, 1996; British Veterinary Association Council – Rabies & Quarantine, 1997; Quarantine for Pets, MAFF, 1997.

Meeting preview
Microbial signalling and communication

A preview of the topics to be discussed at the SGM Main Symposium at Edinburgh, 13–14 April 1999

An inspection of the primary research journals or a search of the publication databases reveals a healthy interest in microbial signalling and communication. Suffice it to say that we felt it timely for the SGM to pay attention to this area by producing a symposium to explore our current understanding of this topic. The forthcoming meeting in Edinburgh, and associated symposium volume, covers a cross-section of material from groups throughout the world who are, and continue to be, leaders in their field. By way of introduction to the subject we should perhaps start with literal definitions.

The terminology

The word signal is defined as 'to send, notify, announce, communicate by means of signals', whereas, communication is defined as 'that which is communicated, a letter, a message, information imparted by speech, writing, etc.' Taking these two interrelated dictionary definitions as they stand would suggest that fundamental to each is an absolute requirement that there is a 'language' based upon a set of symbols, by which the signaller can communicate and be understood by the signalled. As human beings we are constantly signalling and communicating in the form of words, gestures, symbols, etc., to ourselves and each other. These communications allow us to carry out many diverse functions in a 'social' environment with relative speed and efficiency, enabling us to hopefully enjoy and survive another day. At a simpler level, it is known that for successful cell division to occur within a culture of mammalian cells there is a requirement for extracellular growth factors called cytokines, which act as chemical signals. It is becoming clear that similar chemicals also occur in higher plants, multicellular invertebrates and ciliates. Within the world of micro-organisms signalling, communication, and hence information flow, also occur.

Language is the common factor between all methods of communication used by biological organisms. This symposium will attempt to decode and translate the different languages and, by definition, vocabularies (chemical signal molecules) utilized by a wide range of different micro-organisms within various environmental situations. For some micro-organisms we know the chemical structure of the signal molecule(s) utilized; however, in others the structures are far less clear. Perhaps the most exciting feature of the symposium is that we will hear how, and under what conditions, micro-organisms communicate with each other and also other biological cells, and how in some instances we can exploit this knowledge.

Microbial communication

One area of microbial communication that has advanced considerably in recent years is that of bacterial cell–cell communication. This has been facilitated by the discovery of the chemical nature of the signal molecules involved. In most cases they have been shown to be small peptides or a modified form of homoserine lactone. These types of signal molecules have often been referred to as 'pheromones' or 'autoinducers'. Where's the dictionary? If we accept the definition of a pheromone, as 'substances which are secreted to the outside by an individual and received by a second individual of the same species, in which they release a specific action, for example, a definite behaviour or a developmental process', then their *raison d'être* becomes clearer. In most cases this can be viewed as a density-dependent or quorum sensing process, by which a signal molecule is released into the local environment that cannot be detected by an individual bacterium or even low numbers of bacteria. Only when bacteria are at relatively high numbers, or within a confined environment, will a threshold level of signal molecule be reached that can then initiate specific gene expression required for the 'survival' mechanisms peculiar to the genus of bacterium involved. Thus we have the captivating situation of intercellular communication, by signalling, from bacteria that may not be in close physical contact. Examples that we will hear about at the meeting are: antibiotic production and regulation in *Streptomyces* and *Erwinia*; multiplication of prokaryotes and a role in viable-but-non-culturable (VBNC) cells; gene transfer mechanisms in *Enterococcus*; biofilm formation; multicellular differentiation of *Myxococcus* (Fig. 1); and quorum sensing in Gram-negative pathogenic bacteria. Not only will the types and role of signal molecules in all of these diverse processes in prokaryotes be described, but there will also be plenty of

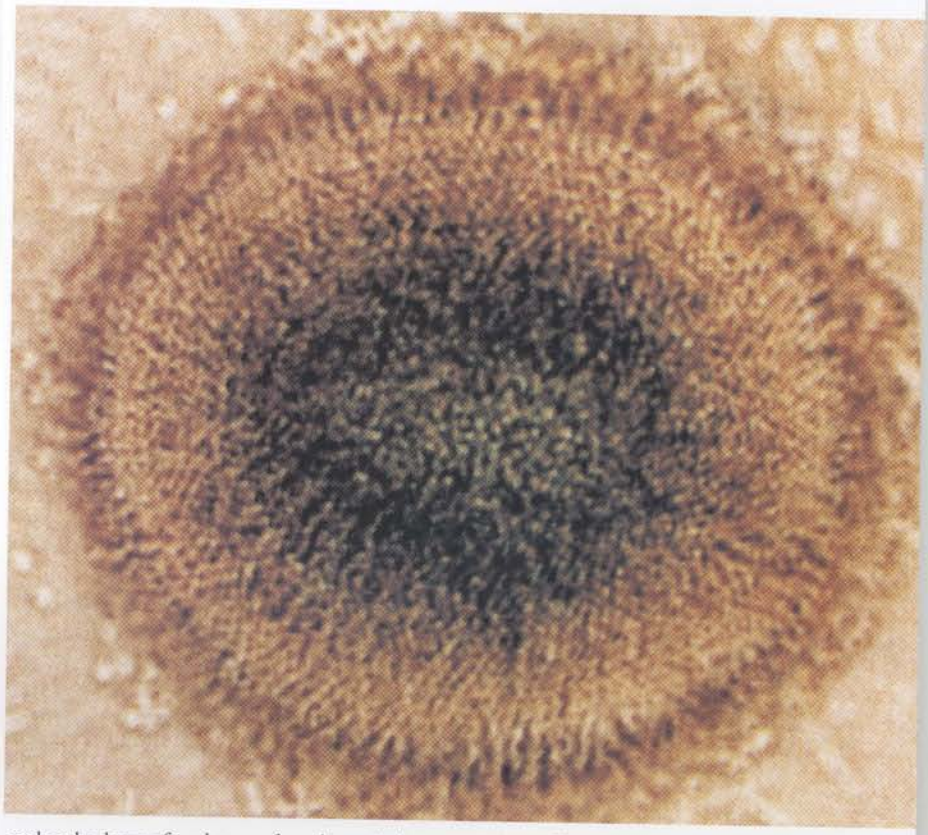


Fig. 1. Fruiting body of *Myxococcus xanthus* viewed from below in bright field optics.
COURTESY D. KAISER, STANFORD UNIVERSITY, USA

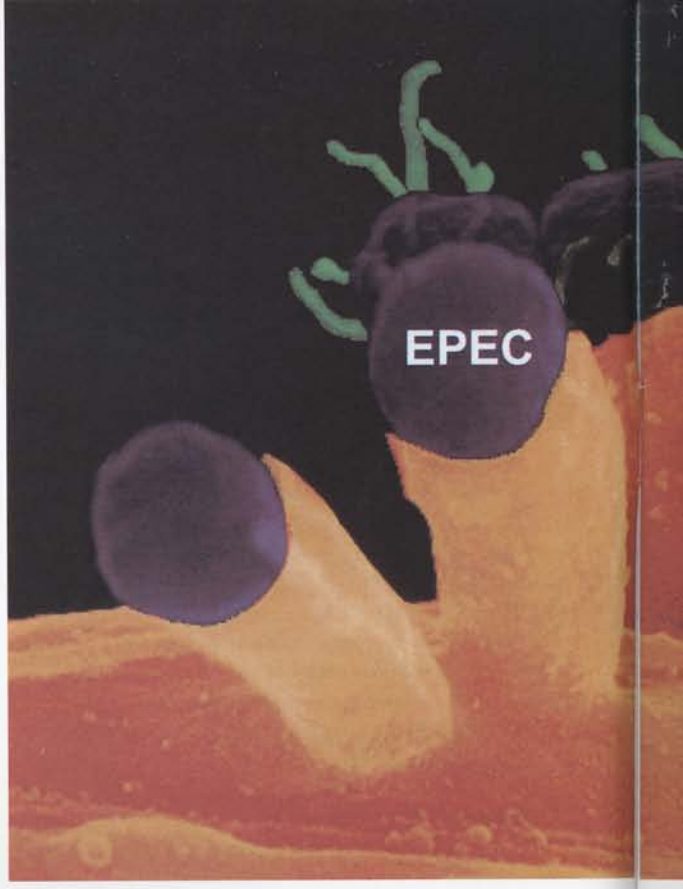


Fig. 2. Artificially coloured scanning electron micrograph showing pedestals produced by EPEC (purple) on cultured epithelial cells (orange). EspA filaments (green) are still present on the surface of EPEC. Magnification x 60,000.
FROM *EMBO J* (1998) **17**, 2166–2176. REPRODUCED WITH PERMISSION OF OXFORD UNIVERSITY PRESS

discussion about the exploitation of the knowledge available to us, either in terms of increasing production of a particular natural product, or conversely, as a target for controlling cellular proliferation, or as a means to help detect otherwise undetectable bacteria.

"*What about the eukaryotes?!*" we hear you exclaim.

Pheromones are not only produced by bacteria. Events in pheromone pathways of yeasts are similar to those found in higher eukaryotes. The fission yeast, *Schizosaccharomyces pombe*, has proved to be an excellent organism for studying the communication processes. The audience will hear about the production and action of peptide hormones on target cells, also how the cell recovers from the effects of stimulation and returns to a resting state. Continuing the eukaryotic theme, chemical communication between fungal hyphae will be discussed. The pheromones involved in the cross-talk between hyphae are very diverse and range from oxygen to peptides, which interact with specific chemoreceptors, coupled to signal transduction pathways within the hyphae.

The life cycle of the slime mould *Dictyostelium discoideum* incorporates key features of morphogenesis found in higher organisms, e.g. chemotaxis, cellular differentiation and multicellular organization. The audience at the symposium will hear about quorum sensing and cAMP in signalling mechanisms and mathematical modelling of cell streams in *D. discoideum*. The accurate prediction of cellular behaviour with models provides reassuring evidence that we do now understand signal mechanisms. The models afford the opportunity to test new hypotheses.

Another group of organisms that will be discussed, and many people will be new to them, are the dinoflagellates. These organisms dominate the plankton of the subtropics in the world's oceans and subsequently are important ecologically and economically. However, very little is known about their signalling mechanisms that have been proposed to mediate cellular processes including encystment, cell division and bioluminescence. Cell-to-cell recognition of endosymbiotic relationships between the coral–dinoflagellate associations is only just beginning to be understood. We will be fortunate to hear the latest information on this fascinating topic.

If your scientific appetite is still not quite whetted and you haven't tried accessing the web for the rail network timetable to Edinburgh, then read on.

Microbes and plant cells

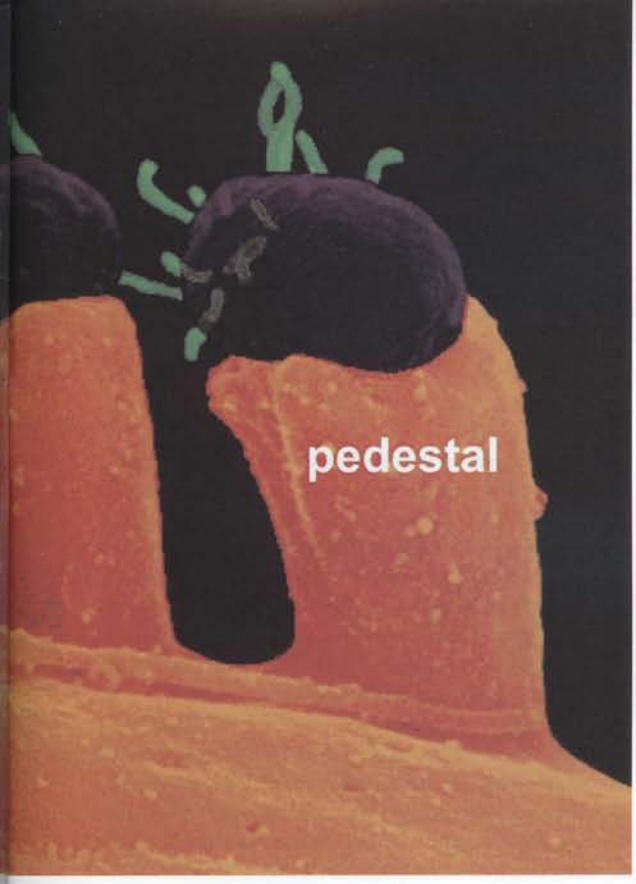
Continuing with cell–cell communication, let us talk plant cells for a moment. Microbial–plant cell communication will be discussed from both pathogenic and symbiotic aspects. The signalling molecules involved in bacterial–plant cell communication can be broadly classified as: synthesized metabolites, e.g. syringolides produced by *Pseudomonas syringae* that infects soybean; secreted proteins, e.g. non-specific plant-degrading enzymes that in some bacteria are regulated via quorum sensing; proteins that are delivered into plant cells causing a hypersensitive response, which eventually kills the invasive bacteria; and nodulation signalling proteins produced by the symbiont *Rhizobium* spp.

Taking up the plant pathogen baton, we will hear about the signalling interactions between the eukaryotes *Phytophthora* and *Pythium* and their host-plant cells. The hallmark of these organisms is their ability to form zoospores that are required for the dispersal of the organism through films of water within wet soils. The signalling systems involve chemical and electrical signals generated by the host plant to guide zoospores to the plant which eventually leads to invasion of the plant cells. Much of the work described will deal with zoospore–root and zoospore–zoospore interactions.

Understanding the mechanisms by which plant-associated pathogens/symbionts produce/regulate synthesis of signalling molecules or respond to plant-induced signals will be of immense benefit to the agricultural industry. It could lead to the development of blocking or enhancing agents, either *ex planta* or *in planta*, depending on the particular requirement.

Microbes and animal cells

Moving on from plant-associated micro-organisms, another extremely important topic that will be addressed is bacterial–animal cell communication. It is recognized that infective bacteria are able to alter eukaryotic signal transduction pathways and thus host-cell functions. As a consequence, invasive pathogenic bacteria are able to overcome the defence mechanisms of their animal host and to reproduce in the tissues. Within the last few years there have been considerable advances in the molecular detail of communication and signalling between pathogenic bacteria and animal host cells. In particular, the mammalian cell targets of some of the bacterial effector proteins have been investigated. To help illustrate the advances made in this important area, work will be presented on the interaction of enteropathogenic *Escherichia coli* (EPEC) (Fig. 2) and enterohaemorrhagic *E. coli* (EHEC) with mammalian intestinal enterocytes and the Yop system of



Yersinia spp. that obstructs a cellular immune response. Clearly, a better understanding of pathogenic bacteria–host cell communication would allow the rational design/development of drugs that could block bacterial effector protein action and/or synthesis.

Concluding this outline of the Main Symposium in Edinburgh, we would like to first apologize to any speaker who feels we have misrepresented their contribution. Second, we encourage scientists from widely diverse disciplines (academic, medical and industrial) to come along, signal and communicate, as there is something for everyone in what should prove to be a very stimulating and thought-provoking session. Third, if you cannot get to Edinburgh then the book will be available from Cambridge University Press.

We hope to see you in Scotland.

Symposium organizers

● ***Dr Reg England***
Department of Biological Sciences, University of Central Lancashire, Preston

● ***Dr Glyn Hobbs***
School of Biomolecular Sciences, Liverpool John Moores University, Liverpool

● ***Dr Nigel Bainton***
School of Biological Sciences, University of Surrey, Guildford

● ***Dr Dave Roberts***
Natural History Museum, London

Further details of this meeting together with a booking form are given in the enclosed Programme Booklet. The symposium will be published as a book. A review and order form will be available in the May issue of 'Microbiology Today'.

Who did invent the Petri dish? The mystery deepens...

Milton Wainwright

Oh the problems of assigning credit to discoveries! Just when I thought I had pinned down the discoverer of the 'Petri' dish as the English scientist, Percy Frankland (*SGM Quarterly* 25, 98–99) I receive news of a counter claim. This comes from Dr Philip P. Mortimer of the Central Public Health Laboratory, Colindale, who wrote a fascinating article (*PHLS Microbiology Digest* 14, 242), almost identical in style to my own, in which he gives credit for the 'Petri' dish to Emanuel Klein.

Klein (1844–1925) was a histologist and microbiologist who, although born in Slavonia, worked in England from 1872 until his death. He made important, and largely overlooked, contributions to microbiology and also wrote an influential textbook called *Micro-organisms and Disease* which, by 1886, had reached its third edition. As Dr Mortimer points out, Klein (on p. 43 of the book), provides a line drawing of his dish and details its use to isolate bacteria. His description of a 'Petri' dish appeared in 1886, the same year as Frankland's. Both descriptions predate Petri's paper by at least a year. Did Klein then beat Frankland to the 'Petri' dish?

The preface to Klein's book is dated November 1885, so it would seem that he was using his dish in the year before the appearance of the third edition of his book. This would give him priority on the invention over Frankland, whose paper appeared in the *Proceedings of the Royal Society* dated June 1886. However, we do not know how long Frankland, or Klein (or, for that matter, Petri), were using their dishes before they published. In the absence of their notebooks it is therefore impossible to assign priority accurately.

In the fourth edition of his book, published in 1889, Klein refers disparagingly to the fact that Petri's name is associated with the famous dish, claiming that he had used his identical dish some years before Petri's paper appeared. Yet, as far as I can tell, Klein fails to mention his dish in any of his papers published prior to 1886. However, in one that appeared in the *Practitioner* of 1887 (i.e. in the same year as Petri's paper appeared) Klein describes how he used his dish to isolate air-borne micro-organisms. This paper is clearly influenced by Frankland's earlier Royal Society contribution on the same subject.

It is also worth noting that Klein, unlike Frankland, suggested that his dishes be covered with a large glass bell jar, thereby making his approach somewhat cumbersome. Petri also used a bell jar in the same way and his description of this dish is almost identical to that given by Klein. The fact that Klein was annoyed when Petri received the recognition for what he considered to be his dish, suggests that Petri, either directly or indirectly, was not the source of his inspiration.

Who then invented the 'Petri' dish? As I stated above, we do not know how long the individual contenders used their dishes before they announced their inventions; as a result, we must rely upon publication dates. At the moment (there may yet be other contenders!), the race is clearly between Frankland and Klein. Since it is such a close run thing, it would be fair to talk about Frankland–Klein (or FK) dishes. However, if on pain of death I had to choose between the two competing claims I would give the result to Frankland, simply because he published details of his invention in a refereed scientific journal, while Klein's description appeared in a book. When assigning authority for a discovery or invention, the former usually has priority over the latter. My result then – Frankland by a nose, with Klein second and Petri nowhere in the frame!

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Handling and distribution of micro-organisms and the law

David Smith, Christine Rohde & Barry Holmes

The authors discuss the responsibilities placed on the shoulders of microbiologists and the potential consequences of failure to follow the national and international legislation. Ignorance is no excuse in the eyes of the law.

Every day curators of national culture collections see the failure of some microbiologists to follow postal, packaging, and health and safety regulations. This not only puts people's health at risk and on occasion flaunts quarantine regulations, but the distribution of some organisms to unauthorized recipients is a criminal offence. Indirectly such actions are bringing about over-regulation which could put even more restrictions on the distribution of micro-organisms for study. Is it that microbiologists are unaware of their responsibilities and, for example, have no idea of the changes in the International Air Transport Association (IATA) Dangerous Goods Regulations or are they ignoring the requirements because of time and cost implications? The World Federation for Culture Collections (WFCC) Committee on Postal, Quarantine and Safety Regulations disseminates information on the ever-changing rules to its members in an attempt to reduce some of the common mistakes. It is evident that such information should be made available to a wider audience.

Micro-organisms are hazardous substances under the UK Control of Substances Hazardous to Health (COSHH) legislation and those of hazard groups 2, 3 and 4 fall under the EU Biological Agents Directive 93/88/EEC. Infectious micro-organisms are also considered to be dangerous goods as defined by IATA Dangerous Goods Regulations. Furthermore, there are restrictions on distribution imposed by national postal authorities where an increasing number of countries prohibit the receipt of Infectious, Perishable Biological Substances (IPBS) and, in some cases, Non-infectious Perishable Biological Substances (NIPBS). How does a microbiologist keep up with changes in regulations governing shipping? The Universal Postal Union (UPU) in Berne provides the relevant facts in the *Universal Postal Convention Compendium of Information*. The latest edition was published on 1 January 1996 and was last updated in June 1998. The Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ) GmbH, Braunschweig, Germany, has compiled relevant guidelines for the shipping of micro-organisms and updates it on a regular basis. This information is published on their web site and further details are available on the WFCC web site (Table 1).

There are many other aspects of handling and distribution of micro-organisms that raise questions. For example, how many shippers of organisms provide health and safety information with, or more appropriately before, despatch of a sample containing known micro-organisms. How many are aware of the training requirements before shipping of dangerous goods?

Table 1. Useful web sites

World Federation for Culture Collections
- http://wdcm.nig.ac.jp/wfcc/index.html

Deutsche Sammlung von Mikroorganismen und Zellkulturen
- http://www.gbf.de/dsmz/shipping/shipping.htm

UK National Culture Collections
- http://www.ukncc.co.uk

Micro-organisms are shipped by various means, by mail, courier or by hand, from one laboratory to another within countries and often across borders or continents. They are sent for identification, reference, research or for production purposes from colleague to colleague, from and to culture collections in a variety of packages. Over the last few years there have been a number of extra requirements placed upon shippers. The EU Directive 93/88/EEC on Biological Agents and 90/679/EEC setting mandatory control measures for laboratories requiring risk assessments on all micro-organisms handled are just two. These require the assignment of each micro-organism to a hazard group, including a positive categorization to hazard group 1, following a thorough risk assessment of all the hazards involved. Organisms that produce volatile toxins or aerosols of spores or cells present a greater risk. It is the responsibility of the microbiologist to provide such assessment data to a recipient of a culture to ensure its safe handling and containment.

Safety in the laboratory is the hallmark of technical excellence

Whether it is compliance with the law, or the duty of a caring employer, the basic requirements to establish a safe workplace are:

- adequate assessment of risks
- provision of adequate control measures
- provision of health and safety information
- appropriate training
- establishment of record systems which allow safety audits to be carried out
- implementation of good working procedures

In the final analysis a safe laboratory is the result of applying good techniques, a hallmark of technical excellence. Good aseptic techniques used by well-trained personnel will ensure pure cultures and will minimize contact with the micro-organism. The importance of its health and safety procedures reach beyond a laboratory to all those who may come in contact with substances and products from that laboratory. A micro-organism in transit will put carriers, postal staff, freight operators and recipients at risk, some organisms being relatively hazard-free whilst others are quite dangerous. The more stringent shipping regulations have evolved because of increasing carelessness and negligence. If sound packaging, correct labelling and information were used then we might see a relaxation in the prohibition of the use of mail systems.

Assessing the risk of exposure to the hazards micro-organisms present is mandatory

Various classification systems exist which include World Health Organization (WHO), United States Public Health Service (USPHS), Advisory Committee on Dangerous Pathogens (ACDP), European Federation of Biotechnology (EFB) and European Union (EU). In

Europe, the EU Directive 93/88/EEC on Biological Agents sets a common base line which has been strengthened and expanded in many of the individual member states. In the UK the definition and minimum handling procedures of pathogenic organisms are set by the ACDP which lists four hazard groups, 1–4, with corresponding containment levels. The Advisory Committee on Genetic Manipulation (ACGM) in the UK prescribes separate but similar regulations for those organisms that have been genetically modified. Similarly, other European countries have advisory committees. In Germany it is the Zentrale Kommission für die Biologische Sicherheit (ZKBS), Robert Koch-Institute, Berlin. The Trade Corporation Association of the Chemical Industry (BG Chemie) advises on how individual Genetically Engineered Micro-organisms (GEMs) should be classified. The assessment of risk in handling GEMs or Genetically Modified Organisms (GMOs) is more difficult as the hazards of the donor and recipient have to be taken into account as well as those of the resulting GEM.

In addition to the risk of infection, other hazards exist such as toxin production or allergenicity. Basing an assessment on the risk of infection is inadequate. Some individuals are more sensitive than others and may respond differently to exposure. The production of microbial toxin in culture media adds to the hazard status of the growing organisms. The toxins produced may be carcinogenic, nephrotoxic, hepatotoxic, haemorrhagic, oestrogenic or cause inflammatory effects. A list of toxin producers can be found in Annexe III, Community Classification of the EU Directive 90/679/EEC.

● Quarantine, postal and packaging regulations become more rigorous the more they are ignored

There are specific requirements for handling pathogenic organisms. All plant pathogens non-indigenous to the UK are controlled and those who wish to obtain cultures must first obtain a Ministry of Agriculture Fisheries and Food (MAFF) licence. Under the terms of such a licence the shipper is required to see a copy of the Ministry permit before such strains can be supplied. A current permit issued by the Forestry Commission is necessary to work on non-indigenous tree pathogens. All shipments of plant pathogens to Canada and the USA must be accompanied by import mailing labels, without which entry of cultures to these countries is refused. The failure to follow these requirements will at the least impede the organism from reaching its intended destination.

The specified Animal Pathogens Order (1998) makes it an offence to possess or spread a listed animal pathogen (e.g. *Brucella*) within Great Britain without a licence. It is supplemented by the importation of Animal Pathogens Order 1980 which makes it an offence to import any animal pathogen, or potential or actual carrier, of an animal pathogen from a non-EU country, except under licence. Both the supplier and recipient must hold the appropriate licences and undergo regular inspections by MAFF.

Countries have their own regulations governing the packaging and transport of biological material in their domestic mail. It is commonplace to send micro-organisms by post, as this is more convenient and less expensive than air freight. However, many countries prohibit the movement of biological substances through their postal services. IATA Dangerous Goods Regulations (DGR) require that packaging used for the transport of hazard groups 2, 3 or 4 must meet defined standards, IATA packing instruction 602 (class 6.2). Packaging for all other organisms must meet EN 829 triple containment requirements for hazard group 1 organisms. Packages must be sent by air freight or courier if the postal services of the countries through which it passes do not allow the organisms in their postal systems. There are additional costs above the freight charges and package costs: if the carrier does not have its own fleet the package and documentation will require checking at the airport DGR Centre for which a fee is also charged. The shipper is exclusively responsible for the shipment, its correct packaging, documentation, marking and labelling. The Dangerous Goods Regulations also require shippers of micro-organisms of hazard groups 2, 3 or 4 to be trained by IATA certified and approved instructors. The basis for all regulations governing the safe transport of goods for all carriers is laid down in the Orange Book *Recommendations on the Transport of Dangerous Goods*.

● The distribution of dangerous organisms to unauthorized recipients is a criminal offence

There is considerable concern over the transfer of selected infectious agents capable of causing substantial harm to human health. There is potential for such organisms to be passed to parties not equipped to handle them or to persons who may make illegitimate use of them. The distribution of such agents is covered in EU Council Regulation 3381/94/EEC on the control of export of dual-use goods (*Official Journal of the European Communities*, L367, p. 1). The 'Australia Group' of countries has strict controls for movement outside their group but has lower restrictions within. The UK National Culture Collections are implementing a system involving the registration of customers to ensure *bona fide* supply (see web site, Table 1). The USA has rules that include a comprehensive list of infectious agents, registration of facilities that handle them, requirements for transfer, verification and disposal. These rules carry criminal and civil penalties. In the UK all facilities handling hazard groups 2, 3 or 4 must be registered and strict control of hazard groups 3 and 4 organisms is in place. Persons being supplied with infectious agents should not avoid these regulations by providing subcultures to third parties.

A much more detailed version of this article, which includes a list of useful references, is available on the SGM web site: http://www.socgenmicrobiol.org.uk

Sources of further information

EU Directives

EU Directives are available from the Office for Official Publications of the European Communities, 2 rue Mercier, L-2985 Luxembourg (Tel. +35 22 929 42615; Fax +35 22 929 42759).

International Air Transport Association

Dangerous Goods Regulations, 1998, 39th edn. IATA, IATA Centre, Route de l'Aeroport 33, PO Box 672, CH-1215 Geneva 15 Airport, Switzerland (Tel. +41 22 799 2525).

● The sovereign rights of the country of origin of genetic resources conferred by the Convention on Biological Diversity (CBD) must be acknowledged

The CBD requires that microbiologists seek prior informed consent from the country in which they wish to collect organisms. They are required to agree terms on which benefits will be shared should they accrue from the use of these organisms. The benefit sharing may include monetary elements but may also include information, technology transfer and training. Inevitably, material transfer agreements are required between supplier and recipient to ensure benefit sharing with, at least, the country of origin. An EU DG XII project, Micro-organisms Sustainable Use and Access Regulation International Code of Conduct (MOSAICC), is working toward standard material transfer agreements to facilitate access to genetic resources whilst adhering to the spirit of the CBD and national and international law governing the distribution of micro-organisms.

A safety data sheet must be despatched with an organism, indicating the hazard group it belongs to and what containment and disposal procedures are necessary.

Article 10 of EU Directive 90/379/EEC regulates that manufacturers, importers, distributors and suppliers must provide safety data sheets in a prescribed format. A safety data sheet accompanying a micro-organism must include the hazard group of the organism, a definition of the hazards and assessment of the risks involved in handling the organism and requirements for the safe handling and disposal of the organism.

In the interests of scientific progress, microbiologists must be able to exchange the organisms upon which their hypotheses and results are based, but they must do this in a way that presents minimum risk to those who come into contact with the organism. They must not fall foul of the laws that control the shipping of micro-organisms as this will inevitably result in ever more restrictive legislation that may make their exchange impossible. Health and safety, packaging and shipping and controlled distribution legislation may be extensive and sometimes cumbersome but is there to protect us and must be followed.

● *Dr David Smith is Chair of the WFCC and Curator of Collections at CABI Bioscience UK Centre (Egham), Bakeham Lane, Egham, Surrey TW20 9TY Tel. 01491 829046; Fax 01491 829100*

● *Dr Christine Rohde is at DSMZ, D-38124 Braunschweig, Germany Tel. +49 531 2616 0; Fax +49 531 2616 418*

● *Dr Barry Holmes is at the National Collection of Type Cultures, PHLS Central Public Health Laboratory, 61 Colindale Avenue, London NW9 5HT Tel. 0181 200 4400; Fax 0181 205 7483*

Save British Science AGM Report

RonFraser

SGM is a corporate supporter of the Save British Science Society, and was represented at the Twelfth Annual General Meeting of SBS held in London on 2 December 1998. Before the meeting, there was an address by the guest speaker, the Rt Hon John Redwood MP, Shadow Secretary of State for Trade and Industry, and a past aspirant to leadership of the Conservative Party. He has responsibility within the shadow cabinet for science and technology.

His theme was very much based on individualism and entrepreneurship; his hero is Josiah Wedgewood for his combination of technical innovation and marketing skills. He agreed that the present UK Government has a big agenda for stimulating science and its connection with business, but felt that the recent increases in the Science Budget had been presented in a misleadingly flattering manner. There were still problems in university funding, not least that academic salaries were too far below those in business. Lack of venture capital for taking discoveries forward to products and services needed to be addressed. He felt that the City of London should think more long-term and have a more adventurous approach to risk-taking, and that the Government should provide tax breaks to companies to encourage investment. He accepted that the previous Conservative administration had been wrong to allow government expenditure on research and the infrastructure to slip so far.

In the AGM itself, the effectiveness and energy of the SBS campaign to raise awareness of the need for science funding was noted, together with the need to continue the effort in the future. Members felt that Government needs to be pressed to provide further increases in funding for several more years, and also to promote the benefits and public understanding of science and technology.

This AGM was the first at which the new Director of SBS, Dr Peter Cotgreave, was 'on the platform'. His PhD is in zoology; after a period of research in a number of countries, he came to SBS from three years with the Zoological Society of London combining research with work on the public appreciation of science and on raising the Zoological Society's profile. He will seek to build on the excellent foundation laid at SBS by his predecessor, Dr John Mulvey. Some of Peter's personal views and his aspirations for SBS appear in *Comment* on p. 48.

● *Dr Ron Fraser is SGM Executive Secretary*

International Development Fund report

Gerry Saddler

Caribbean regional training course on the taxonomy and identification of plant-pathogenic fungi and bacteria of agricultural importance. CAREC, Port of Spain, Trinidad, 22 September–2 October 1998

Taxonomic expertise as a backstop for diagnostic or extension services in the Caribbean region is critical to sustainable agricultural development. This need is emphasized by recent appearances of a number of important plant pathogens; leaf-spot of anthurium caused by '*Acidovorax anthurii*' and black sigatoka disease on bananas caused by *Mycosphaerella fijiensis*. Furthermore, in a recently concluded regional survey carried out by CARINET (Caribbean Network for Biosystematicists) and the regional LOOP of BioNET-INTERNATIONAL, it was revealed that although a cadre of phytopathologists exists there is a dearth of trained biosystematicists. Our course was intended to address this issue by providing specialist training to key personnel.

The omens did not look good; hurricane Georges was about to ravage the region, one of my fellow trainers had lost her voice and then the third piece of bad luck, I fell over and broke my left wrist. Fears that the hurricane would severely disrupt transport and deplete attendance were unfounded since the hurricane passed well to the north and 19 participants from 14 countries were able to make it through to Trinidad.

We were based in the Caribbean Epidemiology Centre (CAREC) in a well appointed lab and teaching facility with excellent local technical support. The course could not have taken place without the magnificent work of Dr Ron Barrow and his assistant Nesha Beharry (CARINET), who provided logistical support and served as the local organizers. Further, as always with courses of this nature, we gambled on finding enough diseased material locally and were grateful for Dr Ralph Phelps, recently retired from the University of the West Indies, in helping us locate a large variety of very sickly plants. The course was designed to be immediately applicable to the majority of our participants who were required by their respective ministries of agriculture to operate disease diagnosis services, amongst other things! The programme was fairly intensive covering the spectrum from 'classical' approaches through to PCR detection. In addition, two colleagues from CABI Bioscience, Babs Ritchie and Paul Kirk, covered general plant pathology techniques and fungal systematics while Ralph Phelps set the scene by providing an overview of local problems.

During the course we were able to visit an anthurium farm severely affected by '*Acidovorax anthurii*', a description of which is soon to be submitted to the *International Journal of Systematic Bacteriology*. Anthuriums are ornamentals which are produced for sale locally to hotels and restaurants and also to the North American market. They are a good example of agriculture diversification away from the traditional regional crops of sugar and bananas. The pathogen itself was first identified in Trinidad by CABI's Identification Service and is gaining in significance as losses on one farm were put as high as 66%. Growers in Trinidad are fearful that the disease has the capacity to wipe out their industry. This disease symbolizes the significance of the course and the need to improve diagnostic skills and thus provide the region with a vital early warning system.

Finally, a vote of thanks to our sponsors. In addition to the support I received from the SGM, my colleagues, the participants and I received funding from the Commonwealth Secretariat, The CABI Partnership Facility (a fund supported by the UK's Department for International Development (DfID), Canada's International Development Agency (CIDA), Australia's Centre for International Agricultural Research (ACIAR) and a Darwin Initiative project led by David Minter of CABI Bioscience to establish a regional identification service for fungi in the Caribbean.

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LEFT:
Anthurium andreanum Lind. exhibiting symptoms of bacterial leaf-spot caused by '*Acidovorax anthurii*': chlorosis of leaves and necrosis of directly affected tissues.

BELOW:
A number of the participants working through one of the many practical sessions.

A European Centre for Infectious Diseases (ECID): a need for the future

Jean-Claude Piffaretti

What can be done to combat the threats from infectious disease in the 21st century? A new collaborative venture is being actively considered by a group of microbiologists from around the world.

Europe and the threat of emerging and re-emerging infectious diseases

At the dawn of the new millennium Europe, like other nations, is facing unpredictable and potentially dangerous threats to public health. Over the past few decades improvements in welfare and the availability of potent antibiotics have led us to regard infectious diseases as all but conquered, but this perception has recently changed dramatically. Overcrowding, socio-economical instability, massive population migrations and inadequate measures to tackle infections will favour the emergence or re-emergence of infectious diseases and the spread of pathogens. Furthermore, global warming may bring infectious diseases from tropical to temperate countries.

Pathogens respect no borders. If we want to maintain control of European public health, we have to co-operate by sharing know-how and costs. It is not enough (although necessary) to build European or even worldwide networks to carry out surveillance; a more aggressive attitude is essential to fight, or better, prevent outbreaks of infectious diseases when and where they arise, and before they become apparent to an alarm network, which might be too late.

Usefulness of a European Centre for Infectious Disease (with walls)

Convinced that Europe should have a centre devoted to the control of infectious diseases, Michel Tibayrenc, Director of the Centre d'Études sur le Polymorphisme des Micro-organismes at ORSTOM, Montpellier, called together an international board of scientific advisers on 11–12 September 1998 to discuss the proposed European Centre for Infectious Diseases (ECID) project. It was evident to all present that a centralized European organization to fight emerging and re-emerging infectious diseases was desirable. The majority considered that a 'bricks & mortar' structure was much more attractive, useful and efficient than a network of existing structures because it would bring together experts in different fields such as research, training and surveillance. This approach received particular support from representatives of developing countries, citing the US Centres for Disease Control (more precisely the National Centre for Infectious Diseases; NCID) as a prestigious and efficient organization.

The proposition, then, is for a main centre, with outstations and corresponding centres, not only in European states, but also in developing countries.

Co-ordination with existing or future European structures

European expertise in terms of research on, and surveillance of, communicable diseases is considerable, so it is crucial that the activities of the ECID are co-ordinated with existing organizations, such as Britain's CPHL and France's Pasteur Institutes, and with health surveillance networks, such as the Réseau National de Santé Publique (RNSP) in France or the European Network for Epidemiological Surveillance and Control of Communicable Diseases, created by the European Parliament last June.

The proposed ECID would have three main goals.

(i) Advanced research. ECID research programmes should be holistic. The opportunity would exist to study infectious diseases encompassing all the parameters of the transmission chain. The advent of powerful technologies such as extensive sequencing projects, genomics, DNA chips, etc., begs a multidisciplinary approach to infectious diseases. This could also be an opportunity to revive some vanishing, although indispensable skills such as traditional, whole-organism microbiology and entomology.

(ii) Surveillance, control and prevention. Surveillance, control and prevention are unquestionably the purview of individual nations. In the USA surveillance and prevention of infectious diseases are the responsibility of each state. The CDC acts as a co-ordinator, adviser and data-gatherer. The ECID could play a comparable central rôle in co-ordinating national and international actions, providing expert advice and collecting information on a broad scale ('European Observatory for Infectious Diseases'). The European potential in terms of surveillance of communicable diseases is already considerable, but requires better co-ordination, which is the aim of the recently created 'European Network for Surveillance and Control of Communicable Diseases'. Hosting this network within the ECID would add considerable value to that initiative.

(iii) Training. The teaching activity of the US CDC is considerable and diverse (short- and long-term visits, simple technical information, in-depth theoretical training, etc.) and helps to train people from many countries, giving them a common language and background. The ECID should also facilitate such practical training as well as co-ordinating its activities with existing bodies, such as the European Programme for Intervention Epidemiology Training and national schemes.

Links with developing countries

One of the priorities of the ECID should be to create strong links with developing countries, through equal partnerships between institutions. From this perspective, the training activity of the ECID should be strongly focused on relevant infectious disease problems. This is not only humanitarian, but it would also combat emerging infectious diseases where they arise, protecting other countries (especially Europe) in a cost-effective manner.

Administrative status and involvement of European countries

Close links with the EU and WHO are essential, but the scope of this proposal exceeds the limits of the European Union and should involve non-EU European countries, particularly Eastern Europe and the former USSR. It is to be hoped that it could achieve international status comparable with the European Molecular Biology Organization, the

European Space Agency or the European Centre for Particle Physics (CERN).

The future

The recommendations resulting from the Montpellier meeting were: first, a more structured proposal is to be prepared within the next 6 months, led by Michel Tibayrenc; second, the present board of advisers is to be broadened, to include epidemiologists and public health practitioners active in Europe; third, the project is to be discussed extensively at the Congress of the European Society of Clinical Microbiology and Infectious Diseases, Berlin, March 1999; finally, additional official support is to be sought from other scientific societies.*

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**Editor's note: ECID has the support of the Swiss Society of Microbiology, the Turkish Microbiological Society and the European Society of Clinical Microbiology and Infectious Diseases. The SGM has not yet been approached formally to support this initiative.*

MicroShorts

Funding

UK Science Budget

The UK government has announced that the extra £700,000m in the science budget over the next three years will be allocated as follows: research councils (£304m), universities (£347m), the Royal Society (£6·4m), other funds (£34m).

Money in a jif

Academics have been putting in their bids for money from the £600m Joint Infrastructure Fund (JIF) which has been set up by the government and medical research charity, the Wellcome Trust. This fund will also last until 2001 and aims to equip universities to carry out high-level scientific projects. The grants will cover equipment purchase and the construction and refurbishment of laboratories. Applications in the life sciences will be processed by the Wellcome Trust, in association with the relevant research councils. The deadline for the first round was in December 1998 but there will be further calls. See **http://www.wellcome.ac.uk** for details.

Foresight LINK awards

A second round was announced in December. The awards are to support innovative, pre-competitive research projects with commercial potential undertaken by companies and universities and other research organizations working together. Projects must fit in with priorities identified by Foresight and preference will be given to applications addressing the following themes: A cleaner world; Social shaping and impact of new technology; and Precision and control in management. For full details and applications forms check the web site **http://www.dti.gov.uk/ost/link/award.htm** or telephone **0171 215 0369**.

The Research Funding Guide

Published by Research Fortnight, this new guide will be useful to all scientists seeking funding. It describes a wide range of funding bodies and schemes, giving full contact details, including e-mail addresses and web sites. There are guidelines on making grant applications and other handy tips.
ISBN 0 9533138 0 8, price £95.
For order details e-mail **fundingguide@researcheurope.com**

NESTA

Funded by £200m from the National Lottery, the UK government has set up The National Endowment for Science, Technology and the Arts 'to support and promote talent, innovation and creativity in the fields of science, technology and the arts'. Interest money from the endowment will be used to sponsor individuals meeting these objectives. Currently the proposals are out for consultation and applications will only be accepted when these are complete. See **http://www.nesta.org** for further information.

Teaching resources

Video

First Steps in Practical Microbiology (30 minutes)

This video provides an excellent introduction to practical microbiology for new undergraduates before they set foot in the laboratory. It is also suitable for 16+ students carrying out microbiology projects. The video is well filmed, with good close-ups of the more intricate procedures, and the narrator describes the techniques in great detail, explaining why the various operations and precautions are necessary. The real basics are covered – laboratory protocol, using a loop, making agar plates, using a bunsen burner, aseptic technique – and there is a strong emphasis on safety, including discard procedures. Other topics include streak plates, broth inoculation, serial dilution, spread and pour plates, bacterial lawns, Gram staining, use of the microscope and some simple antimicrobial sensitivity tests. The video was produced by Bradford University and costs £25 + VAT. Contact Dr Ron Dixon for details (e-mail **r.a.dixon@bradford.ac.uk**).

Biotutor-L

Dr Peter Robinson, a plant biochemist at the University of Central Lancashire, has set up an e-mail discussion list specifically for teachers of biology in schools and colleges (age range 5–18 years). Anyone with a professional interest in the teaching of biology is welcome to join. Students are excluded. The list is used for the dissemination of good practice and to help subscribers resolve the problems they encounter in teaching life science. Anyone wishing to join or advertise an event for schools should contact Peter Robinson (e-mail **p.k.robinson@uclan.ac.uk**).

NCBE gains Millennium Product status

After a nationwide search for Britain's most innovative products, the National Centre for Biotechnology Education at Reading University has been granted Millennium Product status for its DNA equipment which is used to teach molecular biology in schools and colleges. The awards were announced by the Trade and Industry Secretary and the DNA kit may yet find its way into the Millennium Dome. SGM works closely with the NCBE to promote microbiology and biotechnology in schools.

Biotechnology

Public consultation on developments in the biosciences

The UK Office of Science and Technology (OST) has begun a public consultation which will be used to inform policy making (feeding into the new cabinet committee on biotechnology) and help scientists to understand the concerns and information requirements of people in this subject. Guided by an advisory panel with expertise in the biosciences, workshops are being held where members of the 'People's Panel', 5000 individuals representing a cross-section of the community set up by polling company MORI on behalf of the government to canvass public opinion on its policies, discuss issues relating to human health and the environment. Further information is available on the OST web site: **http://www.dti.gov.uk/ost/ostbusiness/index.html**

British Co-ordinating Committee for Biotechnology web site

http://iptunix.bcm.bham.ac.uk/stevew/bccb.html

Laura Potter of Birmingham University maintains this site which mainly forms a database of biotechnology meetings and conferences in Europe. Meetings notices can be submitted via an on-line form or by e-mailing **l.c.potter@bham.ac.uk**
There is a small charge for non-members of BCCB.

Biotechnology Young Entrepreneurs Scheme 1998

37 teams of undergraduates and postgraduates/postdocs competed for £1000 prizes by compiling business plans for imaginary biotechnology ventures. Each team attended induction workshops to learn about the business skills required in establishing biotechnology companies before coming up with their own schemes. Following a two-day final at the DTI in London in December, the undergraduate winners were announced as University of Edinburgh; the postgrad/postdoc prize went to University of Cambridge. Although the winning projects did not feature micro-organisms, many of the entries did. The competition web site is at **http://www.hccdf.co.uk/bty/** where details of the 1999 event will be posted.

SocietyNews

November Council Meeting

New members of Council

● Council welcomed several new officers and elected members to their first meeting: Treasurer, Peter Stanbury (University of Hertfordshire), Professional Affairs Officer, Don Ritchie (University of Liverpool), Education Officer, a newly created post, Liz Sockett (University of Nottingham) and Richard Elliott (University of Glasgow), Colin Harwood (University of Newcastle) and Lynne Macaskie (University of Birmingham).

Student recruitment

● Elected members of Council raised the question of student recruitment to the Society. A recent analysis of figures had shown this to be subject to major geographic variation. The extent of active involvement of students and encouragement of their recruitment clearly varied between different institutions and regions, with a significantly higher success rate in Scotland. It is clear that there is potential for existing established members in other regions to encourage recruitment more actively. Council also discussed the possible introduction of a new category of undergraduate membership.

Investment management

● The Treasurer introduced an item which had earlier been considered at length by the Treasurer's Committee. Peter Stanbury had to report that in line with global changes in financial practice, it was no longer cost effective for the Society's investment managers for some years, Kleinwort Benson Charities Division, which had recently been taken over by the Dresdner RCM investment group, to handle the Society's portfolio of investments as an individually managed fund. Council considered with care the implications of various other options, including transfer of investments into larger managed funds or tracker funds. It was agreed that it would be wrong to take an immediate decision, but that further professional advice should be taken, and a number of alternative investment management companies investigated. The need for careful thought underlined to members the difficulty of knowing what best to do with several million pounds worth of investment. Winning the lottery would undoubtedly lead to headaches as well as joy!

The millennium bug

● The Executive Secretary outlined to Council some housekeeping matters relating to SGM Headquarters. Particularly impressive to those of us who work in the relatively unregulated academic world was the news that the Society's computer systems had been independently checked for Year 2000 compliance. With some minor exceptions in a few items of older equipment due for replacement, all PC hardware had been found to be satisfactory. The PC databases and other software packages have all recently been upgraded, or are currently being upgraded to Year 2000 compliant versions.

General Secretary

● Council noted that the General Secretary, Charles Penn, was due to retire from office in September 1999. A search committee was established, chaired by the President, to seek a replacement. Anyone interested in the post should contact Professor Dalton.

● *Charles Penn, General Secretary*

New Education Officer

Liz Sockett

Liz Sockett, who recently became the new Education Officer on SGM Council, was born in Newcastle-upon-Tyne and got a BSc in biochemistry and microbiology from Leeds University and a PhD in microbiology from University College London. She worked as a postdoc with Professor Sam Kaplan in the USA and then with Professor Judy Armitage at Oxford. Liz is a lecturer in the Genetics Division of Queen's Medical Centre, Nottingham. Her research uses molecular techniques to understand the flagellar motility of an expanding range of bacteria. Liz was heavily involved in setting up and running the inter-faculty BSc in microbiology at Nottingham. She is also active in promoting the public understanding of science. Her projects include explaining microbes and molecular biology to blind students and adults at the Royal National Institute for the Blind New College. Liz also gives lectures to children in schools and for the Royal Institution. She will be working with SGM staff to widen the Society's role in promoting microbiology. She also hopes to make the SGM more attractive to undergraduate students.

New Convener

Systematics & Evolution Group

Gerry Saddler

My first degree was in microbiology at Edinburgh and from there I went on to Newcastle where I did my PhD with Mike Goodfellow on the systematics of alkalophilic streptomycetes. Developing on from this work I did two spells with pharmaceutical companies at Sandoz (now Novartis) in Basle, Switzerland and at the Lepetit Research Centre just north of Milan, Italy. A complete change then followed as I returned to the UK in 1991 to take up an appointment as a bacterial taxonomist at the International Mycological Institute, specializing in the systematics of bacterial phytopathogens. Phytopathogens have been my main interest ever since and I contribute to our microbial identification service, numerous training courses and a variety of externally funded projects. In 1997, as a consequence of restructuring in our organization, I was appointed as the programme leader for CABI Bioscience's Systematics and Molecular Biology Programme, incorporating taxonomists and technicians who specialize in bacteria, fungi, nematodes and insects.

Nominations for Members of Council

Three members of Council, **Prof. R.T. Hay**, **Dr D.A. Hodgson** and **Prof. C.E. Hormaeche**, retire from Council in September 1999. Nominations are invited from Ordinary Members to fill these vacancies.

All nominations must include the written consent of the nominee and the names of the proposer and seconder, both of whom must be Ordinary Members. Members submitting nominations should indicate the main area of microbiological interest of their nominee, who must have been a member of the Society for at least two years.

Nominations should be sent to the SGM General Secretary, Dr C.W. Penn, School of Biological Sciences, Biology West Building, University of Birmingham, Birmingham B15 2TT, to arrive **no later than 23 April 1999**.

Marlborough House News

At Christmas we were sorry to bid farewell to Mary Harwood who has run the Society's meetings since 1995. In her time in the meetings office Mary has streamlined procedures and computerized the booking system so that conferences and events now run very smoothly and efficiently (despite the idiosyncrasies of some of the delegates!). Mary will be well known to many members who attend the meetings and her presence behind the conference desk will be missed. We wish Mary well in her early retirement, which she has taken to spend more time on her activities with the Church of England and the Guide Association.

News of Members

● SGM International Secretary, **Professor Jeffrey Almond**, is leaving the University of Reading at the end of February to take up a new position as Vice President of Research and Development at Pasteur Mérieux Connaught in Lyon, France. His new contact details are to be found on p. 27.

● **Dr Ron Fraser**, Executive Secretary of the Society for General Microbiology, has been appointed to an honorary visiting professorship at the School of Biological Sciences, University of Manchester.

● **Gerald Sheldon**. Long-standing members will be saddened to learn that Mr Gerald Sheldon, SGM's first Executive Secretary who served the Society from 1971 to 1982, has died after a long illness. Mr Sheldon, an ex-colonial civil servant, was appointed to the post when the SGM moved its headquarters from London to Reading, on the purchase of Harvest House, London Road, the Society's first freehold premises. During his period of office the Society provided administrative services for no less than 14 other learned societies as well as handling its own membership and journals.

● The Society also notes with regret the deaths of **Dr J.B. Brooksby** (member since 1945) and **Mr R.W. White** (member since 1965).

SGM Web Site

http://www.socgenmicrobiol.org.uk

The Society's web site has undergone a facelift. The front pages have been redesigned to make it easier to navigate around the site. There are several new buttons, including Education & Careers, Grants & Funding and Professional & Policy Matters. More prominence has been given to *Microbiology Today* by providing a separate button from the Journals. It is hoped that non-members will be attracted to read articles of general interest. The Journals and Meetings pages are currently under redevelopment.

Education & Careers is a completely new section. It covers resources for schools and colleges, details of the Microbiology in Schools Advisory Committee, information on microbiological safety in schools and a list of micro-organisms suitable for use in schools. There are careers advice pages for both students applying for a university place and graduate microbiologists, together with links to other web sites giving information on careers and jobs.

The **Grants & Funding** section has been expanded. Updated application forms can be downloaded for all SGM schemes and there are pages on funding for undergraduates and postgraduate students, a list of useful addresses and links to a range of funding bodies.

Professional & Policy Matters covers SGM submissions to government consultations, news items of interest to microbiologists and other relevant material which will be posted as it arises.

Comments and suggestions should be sent to the webmaster, Duncan McGarva (d.mcgarva@socgenmicrobiol.org.uk).

Grants & Awards

Marjory Stephenson Prize Lecture

Nominations are now invited for the Marjory Stephenson Prize Lecture to be delivered at the Society meeting in April 2000. The Marjory Stephenson Prize Lecture is the Society's principal award and is awarded biennially in recognition of an outstanding contribution in any area of microbiology. The award is made for a specific piece of research which is currently giving rise to important developments in microbiology, rather than to honour a distinguished scientific career. The value of the Prize is £1000.

Nominations from members of the Society, in accordance with the rules set out below, should be sent to the General Secretary, Dr C.W. Penn, School of Biological Sciences, Biology West Building, University of Birmingham, Birmingham B15 2TT **by 30 April 1999**. The General Secretary will be pleased to advise any member who is thinking of making a nomination.

Rules

1. The Marjory Stephenson Prize Lecture shall be awarded biennially for an outstanding contribution of current importance in microbiology, without restriction on the area of microbiology in which the award is made.

2. Nominations for the Marjory Stephenson Prize Lecture shall be made by any two members of the Society; the nominee need not be a member of the Society. Nominations should be accompanied by a statement of the contribution to microbiology made by the nominee, supported by reprints or other appropriate documentation. A brief *curriculum vitae* of the nominee and a full bibliography of his or her work should also be included.

3. There shall be no restriction by means of age or nationality of those eligible for the Marjory Stephenson Prize Lecture. Recipients of the Lectureship may not be nominated on a subsequent occasion.

4. The recipient of the Marjory Stephenson Prize Lectureship will be expected to give a lecture based on the work for which the Prize Lectureship has been awarded to a meeting of the Society, normally the Spring meeting following the announcement of the award. The recipient will be strongly encouraged to publish the lecture in either *Microbiology* or the *Journal of General Virology*, whichever is the more suitable. The choice will be at the discretion of the Editors of the journals.

Colworth Prize Lecture

The 1999 Colworth Prize Lectureship, sponsored by Unilever plc, has been awarded to **Dr Lynne Macaskie**, School of Biological Sciences, University of Birmingham, for her contribution to the application of microbiology to waste remediation. Dr Macaskie will receive the prize of £1000 and deliver her lecture entitled *Applications of micro-organisms to heavy metals and nuclear wastes decontamination* at the Society meeting at Edinburgh on 13 April 1999. A biography of Dr Macaskie, who recently became a member of SGM Council, was published in the November 1998 *SGM Quarterly* (p. 145).

1999 Fred Griffith Review Lecture

The 1999 Fred Griffith Review Lecture has been awarded to **Professor Willie D. Donachie** of the Institute of Cell and Molecular Biology, University of Edinburgh. The invitation to give the lecture is offered in recognition of long and distinguished service to microbiology. Professor Donachie will deliver his lecture entitled *The deceptive simplicity of the E. coli cell cycle* at the Society meeting at Edinburgh on 14 April 1999.

William David Donachie was born in Edinburgh in 1935 but was evacuated to Dirleton (East Lothian) in 1939. The family later reassembled in Dunfermline (Fife) where he grew up. He went to Edinburgh University to study at the famous Institute of Animal Genetics (Waddington, Auerbach, Beale, etc.) and gained first class honours in Genetics in 1957. After his PhD (supervised by Henrik Kacser) he joined Art Pardee's lab in Princeton. In 1964 he returned to Edinburgh but moved again in 1965 to join Bill Hayes' MRC Microbial Genetics Research Unit at Hammersmith Hospital. This unit moved to Edinburgh in 1968 to form part of the first Department of Molecular Biology. He was awarded a personal chair in Bacterial Genetics in 1993. He is a Fellow of the Royal Society of Edinburgh and a member of the Academia Europaea. He has been studying the cell cycle of *E. coli* since 1965.

International Development Fund Award 1998

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 1999 Fund will be advertised in the May issue of *Microbiology Today*.

- **Dr R.W. Briddon**, Department of Virus Research, John Innes Centre – £5089 to run a laboratory training course on the detection and characterization of geminiviruses at Haryana Agricultural University, India.
- **Dr S. Cutting**, School of Biological Sciences, Royal Holloway, University of London – £6100 to run a workshop on contemporary techniques for application in microbiology in Vietnam.
- **Dr P.N. Green**, NCIMB Ltd – £5985 to assist in the establishment of a network of culture collections in Cuba.
- **Professor A.G. O'Donnell**, Department of Agricultural & Environmental Sciences, University of Newcastle – £5100 to run a workshop on the bioremediation and rehabilitation of contaminated land in Thailand.
- **Dr G. Saddler**, CABI Bioscience, Egham – £2169 to run a training course on the systematics of bacterial and fungal plant pathogens in the Caribbean (see report on p. 17).

IUMS Congresses

Sydney
9–20 August 1999

SGM Travel Grants

Please note that it may be possible to submit late applications.

See web site for up-to-date information or contact the Grants Office.

President's Fund

Younger members of the Society are reminded that the President is prepared to consider applications for limited financial support for one of the following:

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

2. Making a short research visit.

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

Grants are usually limited to £100 for attendance at meetings or institutions in the UK and Republic of Ireland, £155 for travel to Europe and £220 for travel to North America, Japan and the rest of the world.

Applicants must be resident and registered for a PhD, or in a first post-doctoral position, 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 position. The full rules of the scheme were published in the November 1998 *SGM Quarterly* (p. 143).

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: Warwick, January 1999; Edinburgh, April 1999; Leeds, September 1999; any other Society Group or Branch meeting in 1999. An application form giving full details of the scheme was sent to each Student Member with their subscription invoice in October 1998. 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.

Vacation Studentships 1999

A limited number of awards are available to enable undergraduates to work on microbiological research projects during the summer vacation. The purpose of the awards is to provide undergraduates with research experience and to encourage them to consider a career in scientific research. The studentships provide support at the rate of £120 per week for a period of up to 8 weeks. An additional sum of up to £400 for specific research costs may also be awarded. Applications on behalf of named students are invited from SGM members in higher education institutions and research institutes. The full rules of the scheme were published in the November 1998 *SGM Quarterly* (p.143). The closing date for applications, which must be made on the appropriate form, is **27 February 1999**.

Details of all Society grant schemes are now available on the SGM web site at
http://www.socgenmicrobiol.org.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@socgenmicrobiol.org.uk

The 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 the following.

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 microbiology courses 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 **4 October 1999**. Applications (single copies) should be sent to the Grants Office at SGM Headquarters.

Awards 1998
Five applications to the Fund were received in 1998. Awards of publications to the value of £200 each were made to **Dr M.E. Hamid**, Department of Medicine, Pharmacology & Toxicology, University of Khartoum, Sudan, **Mr C.A. Meseda**, Department of Microbiology, Ahmadu Bello University, Nigeria and **Dr C. Sanchez**, Department of Biology, Universidad Autonoma de Tlaxcala, Mexico.

Promega Young Life Scientist of the Year Award 1999

24 March 1999 University of Warwick hosted by the Genetical Society

The ten candidates for the 1999 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.

Representing SGM will be:

Susan McGrath
University of Ulster

Elizabeth Mathew
University of Oxford

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.

Elections 1999 to Group Committees

A number of members of Group Committees retire in September 1999 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 20 April 1999** (contact details on p. 27).

Cells & Cell Surfaces (2 Vacancies)

H.F. Jenkinson (C) (Univ. Bristol)	Cell adhesion, yeast/bacterial transporters
J.P. Armitage (Univ. Oxford)	Bacterial motility and chemotaxis
A.M. Carr* (Univ. Sussex)	DNA repair, yeast checkpoints
S. Bruf (Unilever, Vlaardingen)	Fungal cell walls, stress response
V. Koronakis (Univ. Cambridge)	Expression and secretion of haemolysin
D. Quain (Bass Ltd. Burton-on-Trent)	Physiology and genetics of brewing yeast
A.W. Smith (Univ. Bath)	Antimicrobials and host responses
C.J. Stirling (Univ. Manchester)	Membrane translocation, heat shock proteins
I.C. Sutcliffe* (Univ. Sunderland)	Bacterial cell wall composition
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 (5 Vacancies)

P.P. Mortimer* (C) (CPHL, London)	Hepatitis/HIV
E.H. Boxall* (Regional Virus Lab., Birmingham)	Perinatal transmission
D.W.G. Brown (CPHL, London)	Exotic viruses, immunization
R.P. Eglin (PHL, Leeds)	Molecular diagnostics
W.L. Irving* (Univ. Hospital, Nottingham)	Hepatitis, viral immunology
E.A.B. McCruden* (Western Infirmary, Glasgow)	Diagnostic virology, hepatitis C
H.J. O'Neill (Regional Virus Lab., Belfast)	Diagnostic and molecular virology
T.G. Wreghitt* (Addenbrooke's Hospital, Cambridge)	Transplantation
G.B. Clements (CR) (Regional Virus Lab., Glasgow)	

Education (3 Vacancies)

P. Wyn-Jones (C) (Univ. Sunderland)	Health-related water virology
R.H. Bishop (Univ. Ulster)	General and industrial microbiology
J.C. Bunker* (Open Univ.)	Adult education, IT, women in science
T.G. Cartledge (Nottingham Trent Univ.)	Microbial physiology and molecular biology
A.R. Eley (Univ. Sheffield)	Medical microbiology, chlamydial pathogenesis
P.S. Handley (Univ. Manchester)	Problem-based learning, environmental microbiology
H.M. O'Sullivan* (Liverpool Hope Univ. College)	Innovations in teaching, work-based learning
Vacancy	
R.E. Sockett (CR) (Univ. Nottingham)	

Environmental Microbiology (2 Vacancies)

H.M. Lappin-Scott (C) (Univ. Exeter)	Biofilms and starvation survival
C.D. Clegg (Scottish Crops Research Inst., Invergowrie)	Soil microbial ecology
K. Jones (Univ. Lancaster)	Survival of pathogens and biofilms
T. Kearney* (BNFL, Preston)	Biodegradation of xenobiotics
L.A. Lawton (Robert Gordon Univ. Aberdeen)	Toxic cyanobacteria
R.J. Parkes* (Univ. Bristol)	Sediment and subsurface microbiology
K.T. Semple (Univ. Lancaster)	Biodegradation, environmental pollutants, ecotoxicology, bioremediation
G.J.C. Underwood (Univ. Essex)	Biofilms, exopolymers, sediments, algae, nitrification
L.E. Macaskie (CR) (Univ. Birmingham)	

Fermentation and Bioprocessing (2 Vacancies)

R.R. England (C) (Univ. Central Lancashire)	Bacterial physiology and signalling
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
R.A. Herbert* (Univ. Dundee)	Extremophiles, fungal fermentations, fatty acids
B. Kara* (Zeneca Pharmaceuticals)	Microbial physiology of yeasts and *E. coli*
D.J. Mead (Delta Biotechnology, Nottingham)	Applied microbial physiology, process control
G.P.C. Salmond (CR) (Univ. Cambridge)	

Irish Branch (1 Vacancy)

M.A. Collins (C) (Queen's Univ. Belfast)	Food microbiology, molecular genetics
T.G. Barry (Univ. College, Galway)	Molecular microbiology
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
D. Todd* (DANI Vet. Science Division, Belfast)	Veterinary virology/molecular virology
C.W. Penn (CR) (Univ. Birmingham)	

Microbial Infection (2 Vacancies)

P.W. Andrew (C) (Univ. Leicester)	Pathogenicity, *Listeria, Mycobacterium, Strep. pneumoniae*
D.A. Devine (Univ. Leeds)	Antimicrobial peptides, anaerobes, stress, biofilms
B. Henderson (Eastman Dental Inst., London)	Cytokines, host–bacteria interactions
T.J. Mitchell* (Univ. Leicester)	Bacterial pathogenicity, virulence, transgenes, *Streptococcus*
P.C.F. Oyston (CBDE, Porton Down)	Bacterial pathogenicity, *Yersinia*, vaccines
L.J.V. Piddock (Univ. Birmingham)	Antibacteria action mechanisms, resistance
I.R. Poxton* (Univ. Edinburgh)	Bacterial pathogenesis, lipopolysaccharide, anaerobes, *Clostridium*
D.G.E. Smith (Royal 'Dick' School Vet. Medicine, Edinburgh)	Pathogenic mechanisms, bacterial pathogens of animals
C.E. Hormaeche (CR) (Univ. Newcastle)	

Physiology, Biochemistry & Molecular Genetics (3 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
D. Haas* (Univ. Lausanne)	Soil bacteria–plant interactions
M.J. Larkin (Queen's Univ. Belfast)	Biodegradation, survival
G.P.C. Salmond* (Univ. Cambridge)	Density-dependent gene expression, autoinducers
S. Spiro (Univ. East Anglia)	Gene regulation, (de)nitrification
R.E. Sockett* (Univ. Nottingham)	Bacterial mobility, *Rhodobacter*
G.M. Stephens (UMIST, Manchester)	Microbial physiology, anaerobes, fermentation
E.M.H. Wellington (CR) (Univ. Warwick)	

Systematics & Evolution (3 Vacancies)

G. Saddler (C) (CABI Bioscience, Egham)	Systematics of plant-pathogenic bacteria
B. Austin (Heriot-Watt, Edinburgh)	Taxonomy, ecology, fish pathogens, *Aeromonas, Vibrio*
C. Arnold (CPHL, London)	Virus and bacterial evolution genome studies
D.E. Buckley* (SmithKline Beecham, Epsom)	Microbial metabolites, pathogenicity, systematics
J.G. Burgess (Heriot-Watt, Edinburgh)	Marine microbiology
M. Goodfellow* (Univ. Newcastle)	Systematics and biotechnology, actinomycetes
N.A. Logan* (Glasgow Caledonian Univ.)	*Bacillus* systematics, polyphasic taxonomy
W. Wade (Guy's & St. Thomas', London)	Oral bacteria, unculturables
D.McL. Roberts (CR) (Natural History Museum, London)	

Virus (2 Vacancies)

G.L. Smith (C) (Sir William Dunn School of Pathology, Oxford)	Poxviruses
G.E. Blair (Univ. Leeds)	Adenoviruses
J.C. Bridger* (Royal Vet. College, London)	Rotaviruses
I. Brierley (Univ. Cambridge)	Coronaviruses, retroviruses, translation, RNA structure
D.J. Evans (Inst. of Virology, Glasgow)	Picornaviruses, paramyxoviruses 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
E. Hoey (Queen's Univ. Belfast)	Enteroviruses, molecular biology picornavirus taxonomy
A.M. Lever (Addenbrooke's Hospital, Cambridge)	Retrovirus
G.P. Lomonossoff* (John Innes Centre, Norwich)	Plant viruses
T. Wileman (IAH, Pirbright)	African swine fever virus
R.M. Elliott (CR) (Inst. of Virology, Glasgow)	

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Council 98–99

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Meetings

Meetings on the Web

Up-to-date information on future Society meetings is available on the web site http://www.socgenmicrobiol.org.uk

Meetings Organization

The programmes of the Society's meetings 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. 27 for contact details of Group Conveners.

Administration of meetings is carried out by the Meetings Office at:
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Basingstoke Road,
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Reading RG7 1AE
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Fax 0118 988 5656
e-mail meetings@socgenmicrobiol.org.uk

Spring 1999

143rd Ordinary Meeting
University of Edinburgh
12–16 April 1999

● Main Symposium
Microbial Signalling and Communication

A booklet giving full details of the programme is enclosed with this issue of *Microbiology Today*. Any changes will be posted on the SGM web site as they occur. See p. 11 for further information about the main symposium topic.

Special Flights Deal

A special arrangement has been made with British Midland for discounted flights to the Edinburgh meeting. To book ring central reservations:
Tel. **+44 1332 8544854** from outside UK
or **0345 554554** within UK
and quote the reference
R star MICRO.
You will then be asked for a credit card number and tickets will be mailed direct to the address you give. The deal is for the period 12–18 April 1999 and covers all British Midland routes within Europe.

Microscene Noticeboard

At the Spring meeting of the Society to be held at the University of Edinburgh, a board will be set up with advertisements of jobs, postdoctoral positions, studentships, courses, conferences, etc. The notices should be either A4 or A5 in size. Details of the post or meeting and name, address and telephone number of the advertiser should be included. Contributions for the board may either be brought to the meeting or sent beforehand to Janet Hurst at SGM Headquarters.

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 £2000 in the *Young Life Scientist of the Year* event. Please contact the SGM Meetings Office for details of how to enter.

Autumn 1999

144th Ordinary Meeting
University of Leeds
7–10 September

● Main Symposium (7–8 September)
How do Molecules Cross Microbial Membranes?

J. BROOME-SMITH (Univ. of Sussex)	Overview
K. LEWIS (Tufts Univ., USA)	Multidrug resistance efflux
B. POOLMAN (Groningen, Holland)	Sugar transport
B. ROSEN (Wayne State Univ., USA)	Heavy metal transport systems
V. KORONAKIS (Univ. of Cambridge)	Type I protein secretion
A. FILLOUX (CNRS/IBSM, France)	Type II protein secretion
O. SCHNEEDWIND (UCLA, USA)	Type III protein secretion
P. ZAMBRYSKI (Univ. of California, USA)	Type IV protein secretion
U. KUTAY (ZMBH, Germany)	Nuclear transport
S. HULTGREN (Washington Univ., USA)	Pili
S. LACKS (USA)	DNA uptake
S. HIGH (Univ. of Manchester)	SRP
C. STIRLING (Univ. of Manchester)	Protein translocation into the endoplasmic reticulum
A. BAKER (Univ. of Leeds)	Peroxisomes
C. ROBINSON (Univ. of Warwick)	Chloroplast transport
M. SAIER (Univ. of California, USA)	Evolutionary aspects

This symposium will be published in book form. See the August issue of *Microbiology Today* for details and an order form.

● 7 September
Promega Prize Final

A competition to encourage excellence in scientific communication by young microbiologists.

● 7 September
Microbiology for the Non-microbiologist!

Education Group
Organizer: Helen O'Sullivan (osullih@livhope.ac.uk).

● 7–8 September
Cell Lysis in Fermentation and Bioprocessing

Fermentation & Bioprocessing Group
Organizer: Rob Cumming.
Anyone interested in presenting an offered paper or poster should contact the Convener, Reg England (r.england@uclan.ac.uk) **no later than 10 May 1999**.

● 8–10 September
Food-borne Infections and Intoxications

Microbial Infection/Systematics & Evolution/ Physiology, Biochemistry & Molecular Genetics Groups joint with The Pathological Society
Organizers: Ian Poxton, S. Foster, Adrian Eley and N. Logan.
Day 1: Overview of food-borne infections / Overview of pathogenic mechanisms / *Campylobacter* pathogenesis / Mucosal cellular responses in the GI tract to *Campylobacter* / *Listeria* epidemiology / *Salmonella* – *in vivo* expression / *Salmonella* – molecular epidemiology / Salmonellosis in farm animals

Day 2: BSE & nvCJD / Small, round-structured viruses / *Mycobacterium paratuberculosis* and milk / *E. coli* O157 and other VTECs in the UK / VTEC pathogenesis / Clinical experience with O157 / O157 interactions with the host / Mucosal humoral response to O157

Day 3: Acid resistance in *E. coli* / VTEC in the food chain / Animal reservoirs of VTEC / *Bacillus cereus* and other *Bacillus* spp. / Staphylococcal enterotoxin structure / Botulism / Fungi in food and mycotoxins

Titles and abstracts for offered papers and posters should be sent to Ian Poxton (i.r.poxton@ed.ac.uk) **by 10 May 1999**.

● 9 September
Adhesive Structures

Cells & Cell Surfaces Group

Organizers: Anthony Smith (prsaws@bath.ac.uk) and Mike Wilson (mwilson@eastmand.ucl.ac.uk).

This symposium will cover a diverse range of adhesion-related cell-surface macromolecular products elaborated by micro-organisms. Anyone wishing to contribute an offered paper or poster should contact the organizers as early as possible but **no later than 31 May 1999**.

● 9 September
Molecular Machines: Mobile Protein Complexes in Micro-organisms

Physiology, Biochemistry & Molecular Genetics Group

Organizer: Liz Sockett (liz.sockett@nottingham.ac.uk).

The bacterial flagellum / The bacterial flagellar motor / Kinesin, actin and microtubule motility in eukaryotic microbes / Actin-based motility in bacteria / Enzyme complex motility in electron transport systems / DNA recombination machines / Nucleotide polymerases as mobile machines

The organizer would welcome short contributions, especially if they include videos of microbe movement or movement of microbial subcellular components.

● 9–10 September
Deep Subsurface Biosphere

Environmental Microbiology Group joint with the Geological Society Marine Studies Group

Organizer: J. Parkes (j.parkes@bristol.ac.uk).

Bacteria in deep marine sediments / Bacteria under pressure / Geochemical evidence for deep bacterial activity / Deep biosphere in oil reservoirs / Bacteria in salt mines / Bacteria at high temperatures / Aquifer and groundwater microbiology / Bio-geochemical alteration of hydrothermal minerals / Microbial role in concretion formation

Anyone wishing to contribute an offered paper or poster should contact the organizer as soon as possible.

● OFFERED POSTER PAPERS

Offered poster papers are invited on any aspect of microbiology. Titles and authors (including full addresses) should be sent to the Meetings Office at Marlborough House, to arrive **no later than 6 June 1999**. Abstracts will not be required at this stage but authors will later be asked to send their abstract by e-mail for the Abstracts Booklet that will be available at the meeting.

Future Meetings

WINTER 1999/2000
145th Ordinary Meeting
5–7 January 2000
University of Surrey, Guildford

● Virus Infection – Life or Death for a Cell

Plus workshops on *Influenza* and *Exotic Viruses*

Organized by the Clinical Virology and Virus Groups

Deadline for offered papers: **2 October 1999**

Contact Geoff Smith (glsmith@molbiol.ox.ac.uk)

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

● Main Symposium
Fighting Infection in the 21st Century

To be published

Other symposia: Microbial ecology of food poisoning organisms / Molecular epidemiology / Plant infectious diseases / Potable water treatment / Proteases, proteolysis & control / Public education in food & water / Strategies for safe water & food / Transcriptional control circuits in fungi / Vaccine delivery / Virus entry & exit

AUTUMN 2000
147th Ordinary Meeting
12–15 September 2000
University of Exeter

● Main Symposium
Community Structure and Co-operation in Biofilms

To be published

Contact Hilary Lappin-Scott (h.m.lappin-scott@exeter.ac.uk)

Irish Branch

Food-borne Toxic Agents
4–5 March 1999
University College Cork

For further information and to offer papers and posters contact Alan Dobson (a.dobson@ucc.ie)

Developments in Food Science and Technology
21 April 1999
Dublin
Joint meeting with the Royal Irish Academy

Further details from Margaret Critchley (m.critchley@ria.ie)

Joint meeting with the Irish Diagnostic Virology Group
14 May 1999
Marino Institute of Education, Dublin

Commercialization of Microbial Biotechnology
16–17 September 1999
University of Ulster at Coleraine

Recent Advances in Molecular Microbial Ecology
March 2000
University College, Galway

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

Other News

IUMS CONGRESSES

9–20 August 1999
Sydney, Australia

For details see the web site: **http://www.tourhosts.com.au/iums**

Second circulars are also available from the SGM Meetings Office.

ROYAL SOCIETY DISCUSSION MEETING

20–21 October 1999
The Activities of Bacterial Pathogens In Vivo
The Royal Society, 6 Carlton House Terrace, London

Those interested in participating in an offered poster session should send title and abstract to Paul Williams (paul.williams@nottingham.ac.uk) by 1 May 1999.

DISCUSSION LIST FOR PB&MG GROUP

The discussion list is up and running. If you wish to subscribe, send an e-mail to **mailbase@mailbase.ac.uk** with the following in the body of the text (i.e. not in the subject) **join sgm-pbandmg Your name** (e.g. **join sgm-pbandmg Alex Fleming**)

The discussion list home page is at **http://www.mailbase.ac.uk/lis/sgm-pbandmg/**

It is hoped more interest will be shown to justify its continuation.

Hot off the Press

In this new feature science journalist Meriel Jones looks at some papers in current issues of the Society's journals which highlight new and exciting developments in microbiological research.

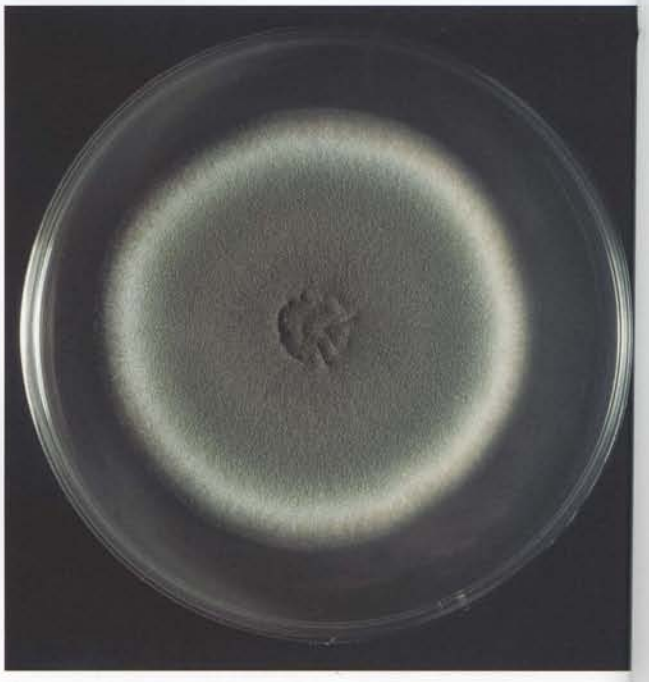
BSE equivalent in sheep?

■ J. Hope, S. C. E. R. Wood, C. R. Birkett, A. Chong, M. E. Bruce, D. Cairns, W. Goldmann, N. Hunter & C. J. Bostock

One current concern about BSE is that, whatever its origin, it may have found its way into British sheep. It is certainly possible to infect sheep deliberately with BSE. Researchers at the BBSRC Institute for Animal Health and the BBSRC and MRC Neuropathogenesis Unit are now part way through a study to see how easily they can detect BSE in sheep, and whether it can be distinguished from scrapie, a natural prion disease of sheep. This is being done by looking at both the disease symptoms in mice inoculated with extracts from sheep brains and the biochemical characteristics of prion proteins in sheep extracts. Samples have been extracted from healthy sheep, from an experimental study where the sheep had been deliberately infected with BSE or scrapie and from preserved brains from natural cases of scrapie. To provide an objective assessment, the whole study has been performed 'double-blind', so that the samples are only known by a code number during the measurements. The mouse studies continue, but data from the biochemical studies has now been reported.

In BSE, the normal cellular prion protein is changed into an insoluble, degradation-resistant form in the brain. Subtle details of its structure can be used as molecular signatures for individual strains of prions, which seem to stay constant as the disease is transmitted from one animal to another. The authors investigated how many types they could detect in extracts from the sheep brains. They found that they could classify their samples into four categories. Two of the categories included 11 extracts from the scrapie-infected animals and the third included samples that did not give satisfactory biochemical results. The final group was the most intriguing. It was from four experimental infections, two with scrapie and two with BSE. As the authors point out, this does not prove that these two are the same. Indeed, this scrapie infection originated in 1970, some 15 years before the outbreak of BSE. Their other experiments have also shown a striking difference between the two in that this strain of scrapie, unlike BSE, has been very difficult to transmit to mice. So, while biochemical tests can easily distinguish some strains of scrapie from BSE, a fuller picture may require more complicated methods.

■ Molecular analysis of ovine prion protein identifies similarities between BSE and an experimental isolate of natural scrapie, CH1641. *J Gen Virol* **80**, 1–4.



THIS PAGE:
Plate culture of *Aspergillus fumigatus*.
COURTESY FRANK ODDS, JANSSEN RESEARCH FOUNDATION

OPPOSITE PAGE TOP:
The marine alga *Delisea pulchra* embedded in an agar plate with the pigment-producing bacterium *Chromobacterium violaceum*.
COURTESY CENTRE FOR MARINE BIOFOULING AND BIO-INNOVATION, UNIVERSITY OF NEW SOUTH WALES, SYDNEY, AUSTRALIA

OPPOSITE PAGE BOTTOM:
Section through a kidney of a guinea pig infected with *Aspergillus fumigatus*. The fungal hyphae are revealed by Gamori methanamine-silver stain.
COURTESY FRANK ODDS, JANSSEN RESEARCH FOUNDATION

Disease in humans is rarely caused by fungi

■ B. Overdijk, G. J. Van Steijn & F. C. Odds

Chitin is a polymer of carbohydrates that makes up the cell wall of many fungi and the exoskeleton of insects. Neither of these gets into animal tissues very often and it was therefore a rather surprising discovery a few years ago that human serum contained something that could take chitin apart, called chitinase. Fungal diseases within animals are quite unusual and can be difficult to treat, so new information is always valuable. The Dutch researchers Bernard Overdijk and Gé Van Steijn have therefore been pursuing the animal chitinase story with their colleague Frank Odds from the Janssen Research Foundation.

One of these pathogenic fungi is *Aspergillus fumigatus*, which can grow throughout the animal's body causing the serious disease aspergillosis. There are two forms of the chitinase enzyme in guinea pigs but only the amount of the larger enzyme increases during infection. The researchers found chitinase in organs that have a major rôle in the immune system, like the spleen, even in healthy guinea pigs. Another tissue containing a substantial amount of chitinase was the lungs, which have a constant rôle in defence against air-borne pathogens, including fungal spores. However, the relative amount in other tissues, particularly the serum, heart and brain which initially contained very little chitinase, increased by up to 400-fold during infection. This work is helping to fill in the picture of one of our innate defences against disease.

■ Distribution of chitinase in guinea pig tissues and increases in levels of this enzyme after systemic infection with *Aspergillus fumigatus*. *Microbiology* **145**, 259–269.

Prions and the species barrier

■ A.F. Hill, M. Antoniou & J. Collinge

Information about prions, the causal agents of diseases like BSE and scrapie, continues to accumulate slowly. After surprising scientists with a way to transmit genetic information without nucleic acids, the exact relationship between prion protein and disease is still unclear. The fact that a version of the prion protein is present in all animal cells means that something special must have happened to it in those unfortunate enough to suffer from a spongiform encephalopathy. The current idea is that the protein has changed shape, with disaster following. One way of checking for this change is to see how well the prion protein resists damage by protein-degrading enzymes. The type found in diseased brain is surprisingly resistant. A few years ago, it was discovered that 'normal' prion protein could be changed into the 'disease' form by mixing the two together in the laboratory. The 'normal' protein was gradually subverted. The question that then arose was whether this test-tube conversion produced exactly the same kind of disease-causing protein that occurs in nature?

The authors have tried to answer this. Animals often have their own version of the prion protein that resists attempts at conversion to the 'disease' form by prions from other species. This is certainly true for mice dosed with hamster prions. However, if parts of the prion gene in mice are swopped for bits of the hamster gene, the mice can become diseased if given hamster prions. What is more, the mixed mouse/ hamster prions produced by these transgenic mice will cause disease in completely normal mice. So, disease-causing hamster prions and 'normal' mouse/hamster prions have been mixed together in the lab. The outcome was that some of the mouse/hamster prions became much more resistant to protein-degrading enzymes. The key part of the experiment was whether this mixture could cause disease if injected into normal mice. A year and a half later, the brains of these mice were still healthy. The authors point out that it only takes about 6 months for mice to show signs of prion disease. Acquisition of enzyme resistance may therefore not be a simple test for the simultaneous creation of disease-causing prions.

■ Protease-resistant prion protein produced *in vitro* lacks detectable infectivity. *J Gen Virol* **80**, 11–14.

Cellular communication

■ M. Manefield, R. de Nys, N. Kumar, R. Read, M. Givskov, P. Steinberg & S. Kjelleberg

One of the most exciting discoveries about bacteria in recent years is that many can communicate with each other using exotic chemicals as signals. For example, acylated homoserine lactones encourage many bacteria to colonize surfaces, particularly those of plants and animals. A group at the University of New South Wales in Australia has been studying how one of their local seaweeds, a red alga called *Delisea pulchra*, protects itself from bacteria that try to grow on it. It is remarkably free of bacterial squatters when compared with other algae. *D. pulchra* produces over 20 compounds in specialized gland cells on its surface which are chemically similar to bacterial signal molecules. The authors have now demonstrated that some of these compounds can enter bacterial cells and interfere with an essential step in the signalling process.

They made use of a system derived from a marine bacterium where the signal molecule triggers the production of light. This involves at least two stages. First, the bacteria synthesize or absorb a signal molecule that must then bind to one particular protein within the cell. This binding alters the activity of that protein so that it triggers production of the protein system required for light generation by the bacteria. This makes a good paradigm for study because the end-product of glowing bacteria is easy to detect. Several of the algal chemicals prevent light production and the group wanted to know exactly how this happened. Through adding mixtures of bacterial and algal chemicals to bacterial cells, they could see that the algal chemicals displaced the real bacterial signal molecules. This interfered specifically with light production and out of 400 proteins the algal chemicals made just 12 go missing. Three of these were ones required for light production. As far as the bacteria are concerned, the seaweed has become invisible.

■ Evidence that halogenated furanones from *Delisea pulchra* inhibit acylated homoserine lactone (AHL)-mediated gene expression by displacing the AHL signal from its receptor protein. *Microbiology* **145**, 283–291.

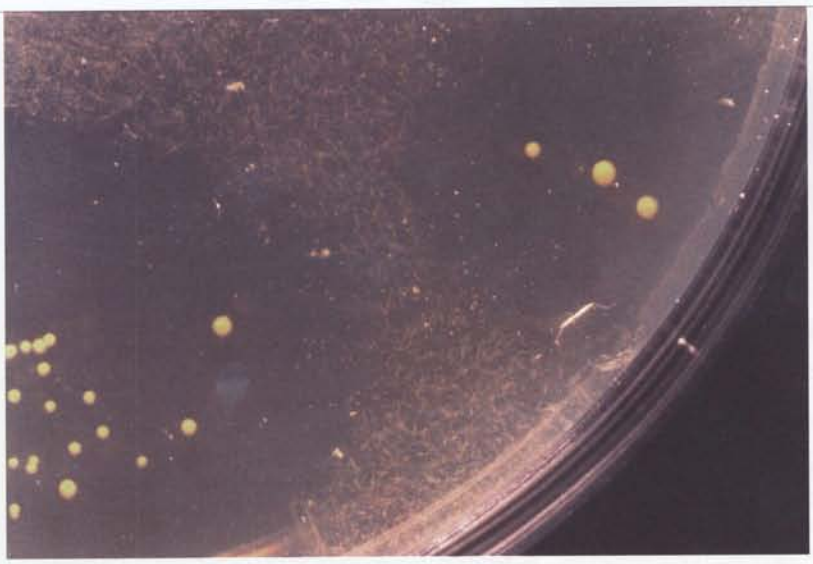
Novel bacterium that degrades lindane

■ R. Nalin, P. Simonet, T. M. Vogel & P. Normand

Lindane has been used as an insecticide and weedkiller for many years, and has recently made the headlines in the UK because of a possible link with breast cancer. Its attractiveness as a protectant is also its problem – it persists for a long time in the environment. This is caused by its chemistry. Biological systems have difficulty in degrading chemicals containing chlorine atoms, and lindane has six of them. This allows lindane to accumulate in tissues, particularly fatty tissues such as the breast. Renaud Nalin and co-workers have been studying one of the few bacteria that are known to degrade lindane.

The bacterium, originally called strain RP5557, was isolated from soil taken from a wood treatment site and kept isolated for over 18 months with lindane as its only food source. To determine its identity, features such as its ability to grow on over 58 food sources other than lindane were tested. This indicated that RP5557 resembled a member of the genus *Pseudomonas*, but with some significant differences. To pin down its identity precisely the researchers sequenced part of one of its genes. The difference between this and every other bacterial sequence in the public databases indicated to the authors that they had found a new bacterial genus, which they named *Rhodanobacter lindaniclasticus*. Looking into the future, it is interesting to speculate that organisms such as *R. lindaniclasticus* may have a rôle in cleaning up our environment.

■ *Rhodanobacter lindaniclasticus* gen. nov., sp. nov., a lindane-degrading bacterium. *Int J Syst Bacteriol* **49**, 19–23.



SGM journals online: *update*

At the time of writing, HighWire Press are processing a total of 20,000 pages of the three journals in preparation for going live. Cambridge University Press have performed a number of 'fixes' on the SGML text, so that it will satisfactorily generate HTML text at HighWire, and graphic files of figures and complex tables are now being integrated. The journal sites will be open as soon as all parties are satisfied with their technical performance: see **http://www.sgmjournals.org**

ABOVE:
Degradation of lindane crystals by a colony of *Rhodanobacter lindaniclasticus* on a Petri dish.
COURTESY R. NALIN, S. COURTOIS, T. VOGEL & P. SIMONET

Diversity of soil bacteria – a new approach

■ Å. Aakra, J. B. Utåker & I. F. Nes

Ammonia-oxidizing bacteria are a crucial part of the nitrogen cycle on this planet. They are the only organisms that can oxidize substantial amounts of ammonia waste products to nitrite, the first step in the cycle. They also have the frustrating character of growing very, very slowly, making conventional bacteriological studies difficult. This has meant that it has been impossible to determine the true diversity of these soil bacteria. Nevertheless, their importance has provoked a lot of scientific attention. Scientists quickly realized that the techniques of molecular biology, which require very small amounts of material, could be ideal for their investigations.

Proteins are synthesized on ribosomes in a process that is both complex and essential for life. The rRNA genes, encoding parts of the structure of ribosomes, have thus been exploited for both identifying and detecting bacteria since changes happen rarely over evolutionary time. Even the DNA between these genes (the so-called spacer) is increasingly being used. It turns out that some regions are identical across broad groups of bacteria while others are unique at the genus or even the species level.

Ågot Aakra and co-workers have now studied the spacer region in ammonia-oxidizers. They discovered that it had a unique sequence in each ammonia-oxidizing isolate, while its length seemed to be species-specific. This technique will be used in the future to determine the true diversity of ammonia-oxidizing bacteria without going through the laborious process of cultivating them first.

■ RFLP of rRNA genes and sequencing of the 16S–23S rDNA intergenic spacer region of ammonia-oxidizing bacteria: a phylogenetic approach. *Int J Syst Bacteriol* 49, 123–130.

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

The ***International Journal of Systematic Bacteriology*** is published quarterly on behalf of the IUMS in conjunction with the ICSB.

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.

Why does the bubonic plague bacterium store iron?

■ J. W. Lillard Jr, S. W. Bearden, J. D. Fetherston & R. D. Perry

The disease bubonic plague is still feared, although there are now only a few thousand cases each year. It comes with echoes from Europe's past, when it killed about one-third of the population in the 14th century. One feature the plague bacterium shares with several other pathogens is the ability to store the iron-containing blood pigment haemin. This characteristic is essential for causing infection in fleas, which are a key link in transmission of bubonic plague to humans. What has never been clear is whether this storage ability is also needed for successful infection of people.

An efficient iron acquisition strategy can be essential to a pathogen. Iron atoms are needed, in small quantities, in several important cell functions. These include transporting and storing oxygen in blood and tissues. The red colour of blood comes from the iron-containing protein haemoglobin which has the transport job. Fleas get their iron by biting people and sucking their blood. They then digest it in their guts where the plague bacterium, *Yersinia pestis*, can intercept haemin from partially digested haemoglobin. The bacteria store such large amounts of it, or even pure iron, on their surfaces that they turn a greenish-brown. The question is: what is it for?

The conventional answer is that *Y. pestis* cells use the haemin as an iron resource once they are spat into a person during the flea's next meal. Since one way that animals defend themselves from bacteria is by making sure that all their iron is tightly locked up, invading microbes have to work to prise it free. Diseases like cholera are primed for success through bacteria invading with their own iron supplies. However, when the authors grew *Y. pestis* in laboratory growth media containing virtually no iron for generation after generation, those that started off covered with haemin or iron fared no better than ones without. The bacteria seemed to be incapable of extracting iron from this store.

An alternative use for it might be as protection against the white blood cells that rush to the flea bite and start to douse foreign cells with peroxides and other toxic chemicals. Iron compounds can catalyse their decomposition. The iron-covered bacteria were certainly better at surviving hydrogen peroxide in laboratory media and could attach themselves to human cells, but they survived no better when offered to white cells for inspection. With all these negative findings, could a haemin coat really had any effect on the virulence of *Y. pestis*? Using molecular biological methods two strains, were created, identical apart from the fact that one could cover itself in haemin and the other could not. The authors injected these under the skin of mice to mimic flea bites. If anything, the strain that could not bind haemin was more virulent. The conclusion was that, despite its importance during infection of fleas, the ability to adsorb haemin really is not important for virulence of *Y. pestis* to mammals.

■ The haemin storage (Hms^+) phenotype of *Yersinia pestis* is not essential for the pathogenesis of bubonic plague in mammals. *Microbiology* 145, 197–209.

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 peers. Contributions are welcome.

Children's microbiology lectures at the Royal Institution

Liz Sockett

Last year, in addition to my occasional microbiology talks in schools around Nottingham, I have been able to reach a London audience by giving lunchtime lectures to children in the Royal Institution (RI) in London. My topic has been *Motoring Bacteria* and the enthusiasm with which it has been received by hundreds of ten year olds has left me staggered. Truly it has been a lot of fun giving these lectures, and hopefully this article on 'a day out at the RI' may encourage some of you to suggest topics for their programme.

So how did I come to be doing this? Well I have always enjoyed giving PUS lectures on my research, so when I saw a note on the web from the RI Education Officer detailing the Schools Lecture Programme it caught my attention. It said that the RI was looking to expand its schools programme from the traditional physics and chemistry to include biological subjects. Teachers had also commented that it would be nice to see more younger scientists and some women involved. I e-mailed the Education Officer and explained that I gave lectures to schools on bacterial motility, and that it was a nicely visible subject for children. He asked me for a talk outline and then invited me to talk to about 400 Year 5 and 6 pupils. Since then I have repeated the lecture twice to another 600 or so children. This year I'll also be giving the lecture in the North of England as part of the RI northern schools programme.

So what is a day at the RI like? Previously I had only ever seen the Faraday Lecture Theatre on television for the BBC Christmas Lectures. 'In the flesh' one sees that it also has a large upper circle from which children lean precariously waving their hands to ask questions! The whole building itself is amazing with the Faraday Museum in the basement and experimental apparatus of famous scientists dotted around. Schools lecturers are loaned an office for the day, complete with *chaise longue* and shelves containing videos, demonstrations and notes from previous lecturers. These include framed notes on science and music by Yehudi Menuhin and mock diamond crystals from Sir Laurence Bragg's lectures. Lecturers are looked after by the prep room team, chiefly by Mr Bipin Parmar who is the current 'man in a brown overall' who brings on demonstrations for the Christmas Lectures. Bipin is happy to give running repairs to models that do not travel well such as my model bacterium with rotating flagella!

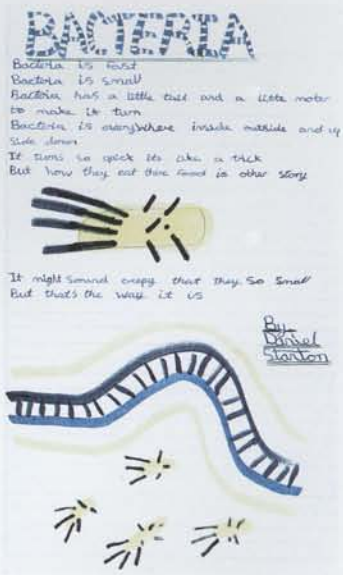
Lectures begin to a set routine of dimming the lights, hushing the children and thrusting the lecturer into a spotlight in the darkened theatre. For someone used to lecturing to undergraduates it is amazing to enter a lecture theatre to the sound of cheering!! My lecture uses models, slides and videos to explain how bacteria swim and sense their surroundings. It seems very appropriate to be talking about flagellar motors in the lecture theatre where Faraday explained the first electric motors! I start with a bit of history of microbiology and then use clockwork animals to explain random movement, a model bacterium with motorized flagellum to explain flagellar rotation, and a lot of simplified cartoon-like drawings to explain cell-surface sensors. I get some volunteers to unfurl a 'giant full stop' to demonstrate how big a dot on a printed page would become if we scaled it up to the size where a bacterium was as big as a Smartie! The children love measuring it with Smarties and it relaxes the audience as they realize the talk is going to be accessible.

Ten year olds have a great capacity for understanding, almost like that of undergraduates. As long as you simplify terminology and begin at the beginning, you can tell them quite complex scientific stories. I explain that bacteria have different sensors which bind and respond to different chemicals, then that the bacteria can change their swimming to respond to the chemicals. Instead of discussing chemicals,

I ask for a show of hands as to who prefers pizza to chocolate. Then I use pizza and chocolate as examples of the chemicals to which different bacteria respond. I take a large model bacterium which I carry around the lecture theatre to explain swimming.

The lecture ends after 45 minutes, but unlike most undergraduate lectures, a frenetic period of questions follows. At ten children have few inhibitions about asking and a sea of hands shoots up. The audience is usually a nice mix of kids in jeans from the east end of London and those from private schools in matching straw boaters. Their questions are priceless and indeed I'd like one day to compile them into a booklet for teachers.

Questions include: "Are there boy and girl bacteria?" "How long do bacteria live?" "How do bacteria go to the toilet, breathe, grow, communicate?" This gets me into about 45 minutes of explaining really good issues like quorum sensing and membrane transport proteins until finally the teachers herd the children off home. I then retrieve Smarties from the Faraday Theatre floor and head back to Nottingham exhausted but elated by such an enthusiastic response to micro-organisms! Sometimes after a lecture I get a pack of poetry in the mail (see example on right) which brightens my day and shows me that they did take away some of the right messages from my lectures!



● *Dr Liz Sockett is SGM Education Officer and can be contacted at Genetics Division, Clinical Laboratory Sciences, Nottingham University, Queen's Medical Centre, Nottingham NG7 2UH*
Tel. 0115 919 4496; Fax 0115 970 9906
e-mail liz.sockett@nottingham.ac.uk

Details of the Royal Institution Schools Lecture Programme may be obtained from 21 Albemarle Street, London W1X 2BS (Fax 0171 670 2920). If you are interested in participating in the scheme, e-mail Andy Pigott, the Education Officer, at schools@ri.ac.uk

New Competition!
SGM Young Science Writer Award

Write an interesting article on a microbiological topic for *Microbiology Today* and you could win £200!

The SGM is sponsoring a new competition to encourage science communication by young microbiologists. The best entries will be published in *Microbiology Today*. The winner will receive £200 and three runners-up will each receive £50 prizes.

Rules

The competition is open to undergraduate and postgraduate students and postdocs under the age of 27. Entrants need not be SGM members.

Articles must be:

- on a microbiological topic of which the writer has first-hand knowledge either through their own research or work that is being carried out in their department
- in a lively, reader-friendly style appropriate for non-specialist readers of a popular science magazine such as *New Scientist* or *Scientific American*
- no more than 800 words in length (excluding legends for any illustrations).

Entries must be typed on one side of the paper only, double spaced, in 12 point font. The writer's full name and address should be given on the first page.

Five copies of each entry should be submitted.

The closing date for entries is 28 May 1999.

The judges decision will be final and no correspondence will be entered into.

The entries will be assessed by a panel of judges who will be looking for interesting research topics, scientific accuracy, clarity of expression and a lively writing style.

A set of competition guidelines is available on the SGM web site: http://www.socgenmicrobiol.org.uk

Entries should be sent to: Writing Competition, External Relations Office, SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AE.

News from Student Societies
Oxford University Biochemistry Society

The OUBS was founded, or so the legend goes, on a cold damp December evening in 1964 by a group of graduate students who wanted to spread their enthusiasm for biochemistry. To this end they drew up a constitution which stated that the society would promote biochemistry by inviting outstanding speakers from outside Oxford to give talks. A lot has changed since 1964 – for example, we no longer charge membership fees but depend on sponsorship instead, we have ceased to hold our meetings at 8.30 pm and (unfortunately) we no longer serve sherry with the lectures.

Despite these changes, we like to believe that the spirit of those early pioneers is still alive and well. We remain a student-run society, which aims to arrange events that are of a general interest to all those associated with molecular life sciences. Indeed, our lectures are attended by people ranging from undergraduates through to senior members of the Department of Biochemistry.

SGM Sponsored Lecture

● *Cracking the Code of Bacterial Cell–Cell Communication*
Professor Paul Williams (Nottingham University)

Taking us on a guided tour through the serendipitous discovery of quorum sensing in *Erwinia carotovora*, Professor Williams revealed bacteria in an interesting light. Instead of single, uniform bugs lurking in a culture flask, bacteria were presented in the environment living in mixed communities obeying nature's 'eat or be eaten rule'. To survive in a rather bleak landscape where nutrient broth is sadly lacking, it is rather an advantage to know who one's neighbours are and whether they are comrades or enemies, allowing members of the same species to conjugate and to work as a team in overcoming life's troubles, such as attacks from warring host immune systems and defending one's niche against invading species.

E. carotovora is a plant pathogen, responsible for turning carrots and other root vegetables into a squishy mess. Its defence mechanism is similar to that of many other bacteria and it produces carbapenum antibiotics to fend off other bacterial species. Carbapenum was originally of interest as it is similar to imipenum, a penicillin-like antibiotic which is capable of targeting bacteria which have become resistant to penicillin. In studying mutants which could not produce the antibiotic, two groups were identified, the first producing an active compound which was secreted into the surrounding medium and the second utilizing this compound and producing carbapenum. The identification of the active ingredient was rather a surprise as it turned out to be a homoserine lactone bearing no resemblance whatsoever to carbapenum. A search for the biological significance of similar compounds revealed that homoserine lactones are also used in population sensing by *Vibrio fischeri*.

V. fischeri can exist in the light organs of deep-sea fish and will produce light for the fish in return for board and lodging in the fish light organ. Producing light is very expensive in terms of energy and is not carried out by the free-living bacteria. The homoserine lactone in *V. fischeri* is produced by the LuxL protein and is received by LuxR. As the population increases, the concentration of the pheromone increases and above a certain threshold, caused by being in a closed system (such as a light organ or a culture flask), LuxR will bind to the *lux* operon and promote the synthesis of the light. This phenomenon is known as 'quorum sensing', activity, being dependent on the density of the microbial growth. A similar system is present in *E. carotovora* and has since been identified in a wide variety of other bacterial species, including *Yersinia*. Despite the similarity between the *luxR* and *luxL* genes and the corresponding *carR* and *carL* genes, the remaining genes are dissimilar and while these two genes are usually found in close proximity they are often in different orientations.

The implications of bacterial cell–cell communications are vast. Professor Williams used an amusing cartoon of ants to demonstrate the kind of damage that can be caused by the co-operation of large numbers of the same species. However, the picture is complex for different bacteria may produce many different kinds of homoserine lactones and other pheromone-based signalling pathways may also be present. Not only can the signals of one's own kind be detected, but one's neighbours may be identifiable by what they produce, and no doubt this is taken advantage of to deduce who is about, friend or foe.

Quorum sensing is an important communication system in the formation of the biofilms that are so very destructive in industry and in hospital environments. These sensing circuits are also potential targets for antibiotics and luckily nature has already produced a potential compound in the furanones produced by red algae.

■ ***Atlanta Cook, OUBS***

See 'Cellular communication' on p. 31.

Bdellovibrio: a predatory microbe

■ Catherine A. Owens

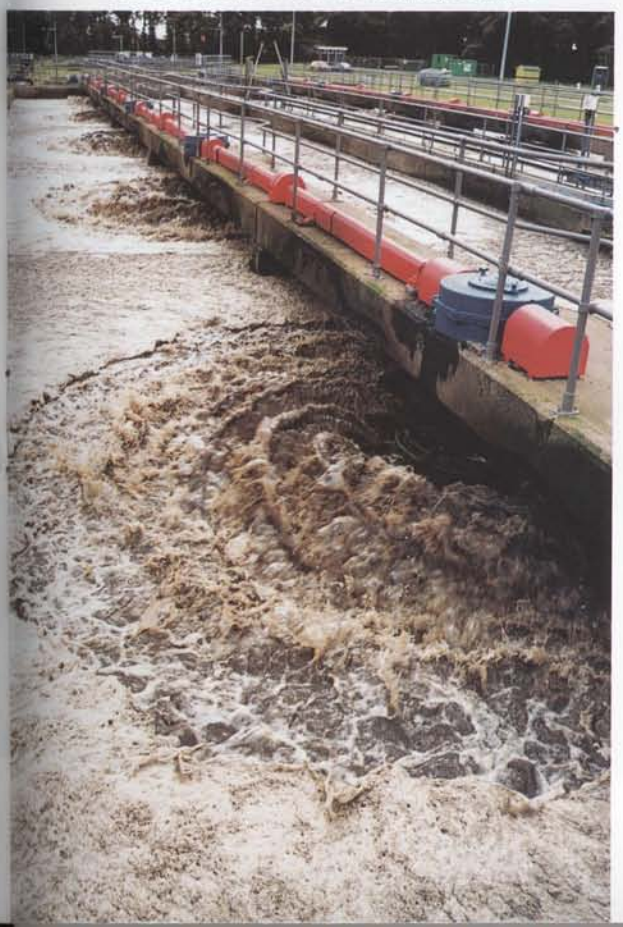
Bdellovibrio is a small, motile Gram-negative bacterium which can use another Gram-negative bacterium as its sole supplier of nutrients (Fig. 1). '*Bdello*' is Greek for leech and the leech-like *Bdellovibrio* was the first predatory bacterium to be identified. Although regarded sometimes as an ectoparasite, it can attach to and enter victims, reproduce inside them and destroy the host, producing maximum numbers of *Bdellovibrio* progeny.

Worldwide, *Bdellovibrio* is found in diverse habitats, including soil, fresh water and marine environments, and sewage (Fig. 2). It was discovered accidentally in 1962 by Heinz Stolp, who, whilst searching for soil bacteriophages, noticed bacteria attacking *Pseudomonas* within 3 days of incubation. They were classified in the genus *Bdellovibrio*, which has, since then, increased in size to include other phenotypically similar organisms.

According to nutritional criteria, bdellovibrios are divided into three main groups:

- *host-dependent* – wild-type and predatory, depending on intraperiplasmic growth in susceptible prey;
- *host-independent* – can multiply on complex media only;
- *facultative* – multiply in the presence or absence of prey cells.

This article will focus on the characteristics and pathogenesis of predatory bdellovibrios *B. stolpii*, *B. starrii* and *B. bacteriovorus*. These were the first to be discovered and appear to have unique characteristics and virulence factors, some of which remain speculative.



ABOVE:
Fig. 1. *Bdellovibrio bacteriovorus* 109j. This strain is unusual in being rod-shaped rather than 'v'-shaped.
FROM WORK ON *BDELLOVIBRIO* GENETICS BY CAREY LAMBERT, AN NERC-FUNDED PHD STUDENT SUPERVISED BY MAGGIE SMITH AND LIZ SOCKETT IN THE GENETICS DIVISION, NOTTINGHAM UNIVERSITY.

BELOW LEFT:
Fig. 2. A sewage treatment plant where *Bdellovibrio* can be found (Severn-Trent sewage treatment plant, Stoke-Bardolf, Nottingham).

Characteristics and life cycle

Predatory *Bdellovibrio* has a morphologically and physiologically biphasic life cycle, alternating between an extracellular, flagellated, non-growing phase and an intracellular, non-flagellated, periplasmic growth phase. The host's periplasm provides *Bdellovibrio* with easy and exclusive access to its cytoplasmic contents. The range of susceptible hosts varies with strain, although it is restricted to Gram-negative bacteria such as pseudomonads and enterobacteria, including *Escherichia coli*, as well as *Azotobacter chroococcum*, *Rhizobium* species and *Agrobacterium tumefaciens*, *Sphaerotilus natans* and *Aquaspirillum serpens*.

Bdellovibrio morphology varies with the life-cycle phase. The free-living, predacious cell is a small, curved or comma-shaped rod. Inside the host cell it acquires nutrients and elongates into a spiral-shape. Finally, it separates into daughter cells with identical morphology to free-living swarmers. (Fig. 3)

Bdellovibrio cell membrane and cytoplasmic ultrastructure is like that of other Gram-negative bacteria. *Bdellovibrio* may be sensitive to antibiotics directed at peptidoglycan biosynthesis. The mobile cell overcomes this constraint by having a high rate of peptidoglycan turnover in its cell wall.

Free-living *Bdellovibrio* has an unusually thick polar flagellum which enables movement at speeds approaching 100 cell lengths per second, about 10 times faster than other bacteria of similar size. The non-flagellated pole of the cell has a ring-like structure, with fibres radiating from it, which possibly acts as a 'holdfast' on the prey. This may be associated with its high phosphonosphingolipid concentration, which is found rarely in other bacteria, and protects *Bdellovibrio* from enzymic activities during initial predator–prey interaction.

Bdellovibrio is obligately aerobic with optimal metabolism at 28–30 °C.

Pathogenesis

The life cycle takes 1–3 hours and includes an attack phase, where *Bdellovibrio*, in a race against starvation, searches for a suitable host. Oxidation of nucleoside monophosphates cannibalized from its own RNA and a high rate of peptidoglycan turnover conspire to limit time for *Bdellovibrio* to find prey. Periplasmic growth precedes the attack phase.

How does *Bdellovibrio* find its prey? In some species it appears to be random whilst other species may move chemotactically towards the ionic environment favoured by their prey. Sometimes *Bdellovibrio* collides forceably with non-living objects or unsuitable prey and becomes transiently attached by its non-flagellated pole. This attachment is loose, non-specific and reversible. The *Bdellovibrio* cell rotates about its longitudinal axis from the point of attachment to the prey cell surface. It may stop rotating, then restart, or detach and swim away.

Although specific receptors remain unidentified, recognition by *Bdellovibrio* of suitable prey may involve interactions with outer-membrane proteins in the host-cell wall, such as lipopolysaccharides. The 'holdfast' may also be involved. After permanent attachment of *Bdellovibrio* to a host the two cells spin together at up to 100 revolutions per second. Within 5–10 min *Bdellovibrio* loses its flagellum and penetrates through the outer cell membrane and the peptidoglycan layer of the prey.

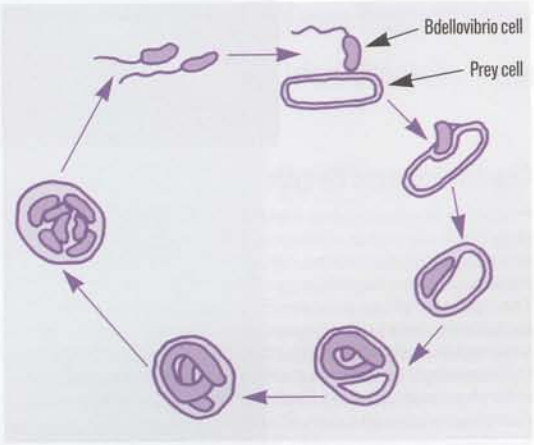


Fig. 3. Biphasic life cycle of predatory *Bdellovibrio*.
AFTER ATLAS & BARTHA (1993).

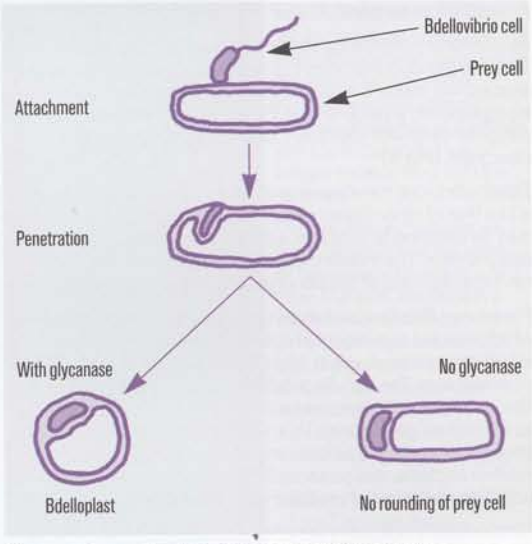


Fig. 4. The suggested role of glycanase following penetration.
AFTER TUDOR *ET AL.* (1990).

The precise mechanism remains controversial, but penetration occurs through a discrete entry pore. The host-cell envelope is breached locally by partial enzymatic degradation. For this to occur *Bdellovibrio* releases lipopolysaccharidase, solubilizing approximately 25% of the amino sugars in the prey's lipopolysaccharide, and a cocktail of enzymes directed against peptidoglycan: glycanase, peptidase and deacetylase.

Glycanase may not be vital for penetration but very shortly after periplasmic entry it is considered essential for conversion of the host into an osmotically stable, spherical bdelloplast, allowing maximum space for *Bdellovibrio* growth (Fig. 4). Following *Bdellovibrio* infection and lodging in the periplasm, enzymatic activity stops and the pore probably closes by self-annealing.

Experiments have shown that paracrystalline protein surface arrays protect Gram-negative eubacteria from predation by *B. bacteriovorus* because the predator is prevented from attaching to the cells. This contrasts with encapsulated *E. coli* which, although protected from most immune defences, is not resistant to *Bdellovibrio*.

Periplasmic entry initiates the transition from attack to growth phase, with *Bdellovibrio* growing unidirectionally for 2–3 hours. Energy is obtained primarily from the degradation of host nucleic acids and lipids, as well as from the oxidation of both acetate, via the citric acid cycle, and amino acids. Intraperiplasmic *Bdellovibrio* can transport ATP by a specific energy-requiring process, characteristic of an active transport permease.

In contrast to bacteriophages, *Bdellovibrio* has a complete set of catabolic, anabolic and energy-generating enzymes, and an exceptionally high biomass yield per ATP molecule expended. Growth efficiency, more than twice that for *E. coli*, is due mainly to the ability of *Bdellovibrio* to take up and re-utilize biosynthetic monomers without unnecessary degradation. It constructs DNA, RNA, lipids and proteins from monomeric units derived from the substrate cell, remanufactures the prey's lipopolysaccharide and relocalizes the prey's outer-membrane proteins to its own membranes. Some marine bdellovibrios require chloride salts for growth, suggesting that factors in natural sea water are essential for their development.

During growth *Bdellovibrio* probably secretes degradative enzymes which are translocated to the host cytoplasm. Some suggested mechanisms for this transport are shown in Fig. 5. Cytoplasmic chaperone host proteins may catalyse correct enzyme foldings in the host.

Macromolecules are digested to smaller, hydrophilic ones, small enough to penetrate the permeabilized plasma membrane, but too large to escape the bdelloplast. Host messenger RNA and protein synthesis cease within 3 and 6 minutes, respectively, and, after about 45 min into the growth phase, *Bdellovibrio* initiates DNA replication. Within 60 min nucleases degrade the prey's DNA to deoxynucleotides, conserving the high energy phosphoester bonds.

While considering host destruction, it appears that very shortly after infection *Bdellovibrio* mediates the insertion of a non-specific pore protein into the cytoplasmic membrane, so that cytoplasm leaks into the periplasm. The proton gradient is disrupted, inhibiting respiration, and so the host dies. Extraction of its contents continues with subsequent shrinkage of the membrane, but without extensive loss in physical construction. *Bdellovibrio* does not retain all prey components and some membrane-derived oligosaccharides, constituting a potential organic nutrient source, are lost. Intracellular signals regulating the progressive loss of host-cell functions and *Bdellovibrio* intraperiplasmic growth may involve chemicals or physical stimuli provided by the prey. Starvation alone does not initiate an attack phase.

Bdellovibrio may promote its own solute uptake by relocalizing prey porin proteins, without loss of function, into its own membranes. The acquired protein is trimeric and retains its correct orientation, allowing the passive diffusion and uptake of low molecular mass, hydrophilic substances. In *E. coli*, OmpF is acquired preferentially, although OmpC and PhoE porins may relocalize too. The Lc protein is very similar genotypically to the other porins, but is not acquired, suggesting small structural differences are important. Relocalization is influenced by the prey and is diminished in those expressing smooth lipopolysaccharide.

At the expense of the prey's protoplast, *Bdellovibrio* elongates, without cell division, sometimes to 20 times its original length. The multinucleated filament septates to produce individual, identical curved rods. The ultimate filament length and number of progeny is proportional to the prey cell volume. For *E. coli* an average of 5–7 bdellovibrios have been reported and 8–12 and 20–30 bdellovibrios for *Pseudomonas fluorescens* and *Aquaspirillum serpens*, respectively. Each rod develops a flagellum and releases lytic enzymes from within the bdelloplast which degrade the modified prey peptidoglycan. The bdelloplast lyses suddenly and the unit-sized progeny are freed for their urgent and solitary pursuit of prey.

One predatory *Bdellovibrio* strain may express an encysted, 'resting stage', termed a bdellocyst, which is made within the bdelloplast. It has enhanced resistance to high temperature,

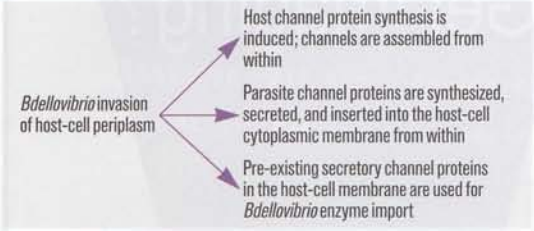


Fig. 5. Possible mechanisms for *Bdellovibrio* protein import into infected hosts.
AFTER SAIER (1994).

dessication and disruption, and germinates to produce attack-phase bdellovibrios. This compares with the Gram-negative *Bacillus*, which may produce similar endospores in an unfavourable environment.

Applications and future research

How can the unique activities of *Bdellovibrio* be exploited by scientists?

One potential area is in pollution control. The organism is found with sewage effluents in rivers and may be absent in unpolluted waters. Its correlation with pollution may be a useful indicator of water quality. *Bdellovibrio* is also important ecologically because, with protozoa and bacteriophages, it helps to control the population growth of other bacteria. Usually in nature *Bdellovibrio* corresponds well with prey density and typically $1{\cdot}5 \times 10^5$–$1{\cdot}5 \times 10^6$ prey per ml may be required to sustain a *Bdellovibrio* population.

As harmful as it is to other bacteria, *Bdellovibrio* is thought to be safe for humans and could be used to exterminate harmful bacteria. The US Department of Agriculture is investigating the use of *Bdellovibrio* to control *Salmonella*. Perhaps *Bdellovibrio*, introduced into chickens via food or water, will survive to kill the pathogens.

Future experiments may identify the precise mechanism for protein entry into the host and *Bdellovibrio* could be used for the study of gene expression during development. Results could highlight possible unexpected parallels with protein import into eukaryotes. Thus *Bdellovibrio* could provide an all-bacterial model for examining the detailed molecular mechanisms concerning bacterial and viral virulence in plants and animals.

Although *Bdellovibrio* is predacious, it does not destroy all natural susceptible prey populations completely. Bdelloplasts have been identified where intraperiplasmic bdellovibrios harboured the assembled capsids of bacteriophages in their cytoplasm. The single-stranded DNA phage MAC1 (family Microviridae) is a *Bdellovibrio* virus. Thus *Bdellovibrio* numbers can be restricted by a predator of its own.

Pathogenesis and factors controlling the host–parasite relationship are continuing to be researched. Meanwhile *Bdellovibrio* remains a fierce predator in the natural environment.

● *Catherine A. Owens graduated with Honours Class 1 in Biological Sciences (Microbiology) from the University of Birmingham in 1998. Since then she has worked in Yellowstone National Park, Wyoming, USA, employed by NASA and assisting with the design, co-ordination and data collection for research into 'Mycorrhizal Community Structure and Specificity of Symbiotic Relationships', with regard to native pine trees. Currently she is employed as a Quality Analyst in the Microbiology Laboratory of Guinness Brewing (Great Britain) before making a trip around the world. This article was written when she was a third year undergraduate student.*

Further reading

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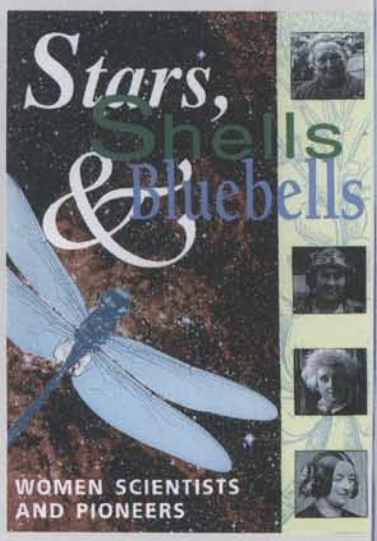
Letter

Dear Editor

Women in Microbiology

I read with interest the article on *Women in Microbiology* in the November 1998 issue of the *SGM Quarterly*. As a microbiologist in academia I must agree that determination and hard work are the key to success.

I did take a career break for seven years (to have children and travel with my husband's job) leaving a lectureship position in the London School of Hygiene and Tropical Medicine. I returned to the laboratory as a very junior research assistant and made it back up to lecturing again and am now at the University of Limerick. What I found difficult was that because of the career break there was a gap in my publications and it was hard to get research grants. Also age limits for new researchers disqualified my applications.



I have become involved in an Irish voluntary organization, WITS (Women in Technology and Science), which is promoting women representatives on government bodies, panels, etc. We have published a book on 15 Irish women scientists, *Stars, Shells and Bluebells*. We would like to do a second volume and are looking for other women scientists of Irish descent. I would be delighted to hear from SGM members who come across any.

● ***Dr Catherine Adley***
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e-mail Catherine.Adley@ul.ie

Women in Science – The Athena Project

Backed by the funding councils, the CVCP and Office of Science and Technology, the Athena Project aims to increase the number of women working in science, engineering and technology at all levels in higher education (HE). It is run under the auspices of the Commission on University Career Opportunity (CUCO). As part of the Athena programme a Women's Register is being set up which is open to any women working in HE. It will collect, analyse and disseminate information, address significant issues and offer services to its members. Contact Athena Project Director Dr Susan Bullivant for details (Tel. 0171 419 4111).

Reviews

A classified compendium of book reviews from 1996 to the present is available on the SGM web site.

Methods in Yeast Genetics. A Cold Spring Harbor Laboratory Course Manual. 1997 Edition

By A. Adams, D.E. Gottschling, C.A. Kaiser & T. Stearns
Published by Cold Spring Harbor Laboratory Press (1998)
US$59.00, pp. 177
ISBN: 0-87969-508-0

Over the decades the *Cold Spring Harbor Laboratory Course Manual* has become the standard source of recipes and protocols for genetic analysis of the budding yeast *Saccharomyces cerevisiae*. The latest edition maintains the high standards of previous editions. The course itself consists of a series of model genetic experiments designed to formally introduce many of the classic techniques of yeast genetic analysis. Its particular value lies in the recipes and protocols described for the everyday manipulations in any yeast lab. Following the publication of the yeast genome sequence, methodology in this field is currently moving very rapidly. The manual does not attempt to keep up with the more recent developments. So while it is an ideal primer for the novice and an authoritative reference source for the classic techniques, an advanced practitioner may require something more. For this I recommend the recent *Methods in Microbiology*, Vol. 26: *Yeast Gene Analysis*, edited by Alistair Brown & Mick Tuite.

■ ***Peter Sudbery***
University of Sheffield

Bacterial Infections of Humans. Epidemiology and Control, Third Edition

Edited by A.S. Evans & P.S. Brachman
Published by Plenum Publishing Corporation (1998)
US$125.00, pp. 888
ISBN: 0-306-45320-7

The third edition of *Bacterial Infections of Humans* will not disappoint. The text is concise, interesting and has a very readable style. Each chapter includes accurate and well researched descriptions of bacterial infections, including a historical review of the topic and up-to-date information on the identification and characterization of bacteria. The emphasis of the text is biased towards bacterial diseases which are common in the US; however, rarer infections such as ehrlichiosis and tularaemia have not been omitted. The only disappointment is the lack of good quality illustrations. Many sections would have benefited from colour photographs to complement the text. I believe this text would be useful as a general reference book for all undergraduates in biomedical science, medical students and many postgraduate students. The size and the price of this book will probably restrict individual purchases and it is more likely to appeal to universities and libraries.

■ ***Dany Beste***
CPHL, Muswell Hill

Mycoplasma Protocols. Methods in Molecular Biology, Vol. 104

Edited by R. Miles & R. Nicholas
Published by Humana Press (1998)
US$79.50, pp. 336
ISBN: 0-89603-525-5

This latest book in the series is a bit of a misnomer, being more of a 'hands-on' laboratory guide to mycoplasma culture and serology rather than a detailed compilation of molecular techniques. Specific examples are covered (e.g. the problems inherent in expressing mycoplasma genes in *E. coli*), although the real strength of this volume lies in its detailed coverage of those methods most likely to be used by anyone involved in or considering mycoplasma culture and/or diagnosis. The editors have wisely chosen to concentrate on protocols rather than background (as opposed to the similar 'Molecular and Diagnostic Procedures' in mycoplasmology books which tend to fall too much between two stools) and as a result have produced a concise, detailed volume which is an essential laboratory component to labs performing or considering basic and advanced mycoplasma techniques. Recommended.

■ ***John B. March***
Moredun Research Institute

ICRF Handbook of Genome Analysis, Vols 1 & 2

Edited by N.K. Spurr, B.D. Young & S.P. Bryant
Published by Blackwell Science (1998)
£149.50, pp. 987
ISBN: 0-632-03728-8

A good cookbook does more than list recipes – it inspires. This set of manuals for genome analysis contains not only a comprehensive list of recipes, but also a tremendous amount of biological information. Together, the combination is inspirational.
The manuals comprise a collection of chapters written by an extensive range of authors and the editors have done an excellent job ensuring continuity. Production is first-rate and the layout clear and effective in portraying complex tables, diagrams and decision charts. The manuals are large, but well designed for lab use, with hard-cover spiral bindings that ensure pages open easily and remain flat while being protected from damage. The first volume describes techniques and protocols for use in genome mapping and chapters are supported by extensive background information on methods and applications.
Also included are valuable sections on strategy evaluation. The second volume is divided into three sections that cover DNA sequencing strategies, model genomes and a description of Internet resources. The section on model genomes is highly informative and makes interesting reading in its own right.
The chapters cover the major genome sequencing projects and are an excellent, and surprisingly up-to-date reference source. For example, the chapter on *E. coli* includes information from the recently published complete genome sequence. My one concern is that these chapters, contained as they are within a laboratory manual, may be overlooked and that would be unfortunate.
The focus of the manuals is clearly the human genome and there is considerable emphasis on approaches for mapping, isolating and identifying human disease genes. The books will therefore appeal mostly to mammalian geneticists; however, DNA is DNA and a 'disease gene' is simply a label. Microbiologists are just as interested in tracking down specific mutations as are mammalian biologists and we can always benefit by broadening our range of experimental tools. Consequently, there is much in these manuals for microbiologists, whether prokaryotic or eukaryotic in persuasion and I am certainly pleased to see them in use in my lab.

■ ***Paul B. Rainey***
University of Oxford

Recent Advances in Microbiology, Vol. 5

Edited by Valerie Asche
Published by The Australian Society for Microbiology (1997)
A$65.00, pp. 221
ISBN: 0-9594930-7-7

This book deals with a variety of diverse aspects of microbiological research in Australia and New Zealand. The topics dealt with range from the wildlife reservoir of equine morbillivirus to the process microbiology of the activated sludge water treatment system. A chapter on improvement of Aboriginal health is also included. The book makes interesting reading. All the chapters are well written and self explanatory – an essential feature for scientists who have limited knowledge of any of the themes dealt with. In general, a brief but good account of the history of the topic is given and each chapter provides an extensive reference list enabling the reader to get additional background reading if required. Although dealing with research in Australia and New Zealand, most of the topics should be of general interest to all microbiologists. The price is not exorbitant and should be affordable for most institute libraries.

■ ***Elizabeth Hoey***
The Queen's University of Belfast

Modern Optics, Electronics and High Precision Techniques in Cell Biology

Edited by G. Isenberg
Published by Springer-Verlag GmbH & Co. KG (1998)
DM248.00/öS1811.00/sFr224.00/£95.50/US$169.00, pp. 261
ISBN: 3-540-62673-5

This is a strange and interesting book, strange because its chapters lack a unifying theme, and interesting because it introduces some ingenious new methods for studying molecules and cells. The chapters show a wide range of quality, from the simply excellent to the rather boring, with little novelty (only two post-1984 references) and the use of stilted Germanic English. The two longest chapters, both on actin filament conformations and dynamics, are physically separate and poorly cross-referenced, one being spoiled by annoying errors (microtubule diameter ~ '120 nm', 'double-helical structure of F-actin' . . . that could 'partially untwist', the square root of 2 = '1.42', etc.), reflecting poor editing. Overall, however, this book provides an accurate, varied and mind-expanding window into much of what is best in modern microscopy and biophysics. Too diverse in content to be a useful research text, this book will nevertheless repay careful reading by biophysicists, physiologists and structural cell biologists.

■ ***David Shotton***
University of Oxford

The Biology of Nitric Oxide, Part 6. Proceedings of the 5th International Meeting on the Biology of Nitric Oxide, September 1997, Kyoto, Japan

Edited by S. Moncada, N. Toda, H. Maeda & E.A. Higgs
Published by Portland Press Ltd (1998)
£110.00/US$187.00, pp. 380
ISBN: 1-85578-127-1

NO Easy Read! The Kyoto conference that generated this book was held in September 1997 on the 10th anniversary of the first identification of nitric oxide (NO) as a biological mediator in vascular endothelial cells. The reasonably prompt publication is welcome and essential, given the furious pace of research on the interactions between biological systems and NO and NO-related reactive species. This book contains nothing but 335 one-page abstracts, all based on the meeting's oral communications and 400 posters, and each crammed with information. Microbiologists will find only a handful of papers on NO interactions with micro-organisms and perhaps too much on NO synthases and pharmacological aspects. There is nothing, for example, on denitrification and NO reductases, and little on the bactericidal effects of NO and microbial responses. The subject index is inadequate and the price 'NOxious'. Nevertheless, I came away enlightened and with ideas: what more could I ask?

■ ***Robert Poole***
Krebs Institute for Biomolecular Research, University of Sheffield

Pichia Protocols. Methods in Molecular Biology, Vol. 103

Edited by D.R. Higgins & J.M. Cregg
Published by Humana Press (1998)
US$74.50, pp. 284
ISBN: 0-89603-421-6

The methylotrophic yeast *Pichia pastoris* has become the leading yeast vehicle for expressing recombinant proteins. Originally, the system was based on the powerful but regulatable AOX promoter, but recently the constitutive GAP promoter has been widely used. A well designed kit, incorporating basic protocols, vectors, strains, a positive control expressing human serum albumin, is available from Invitrogen. Using these tools a wide variety of proteins has been successfully expressed in this yeast. Both the advanced practitioner and the novice in this field require only one more resource – this book. Quite simply, buy and study every word of this book if you work with *Pichia pastoris* or the related *Hansenula polymorpha*. It contains detailed accounts of successful expression projects using this yeast. Particularly valuable is the chapter on high density fermentation by Jayne Stratton and her colleagues, containing detailed advice on an aspect that is poorly covered elsewhere in the literature.

■ ***Peter Sudbery***
University of Sheffield

Antiviral Therapy

By E. Blair, G. Darby, G. Gough. E. Littler, D. Rowlands & M. Tisdale
Published by BIOS Scientific Publishers Ltd (1998)
£18.95, pp. 161
ISBN: 1-85996-070-7

The antivirals area has come of age conceptually and practically, so a general overview is opportune. The content is sensibly arranged with an introductory chapter to set the historical scene, followed by a set of more detailed chapters on areas of virology which have received major attention and winding up with some informed speculation about future developments and acknowledgement of the more subtle diseases. On the negative side, some parts of the presentation (e.g. the well trodden area of the herpesviruses and some details of molecular virology) are a little tortuous in striving for completeness and may risk over-taxing the less specialized reader.
Succeeding overall in its aim to serve a general readership, the style is light, informal and highly readable. Typographical and odd factual shortcomings aside, this concise but well filled and down-to-earth book provides a timely, up-to-date and solid overview of antiviral therapy as we target the next generation of drug developments in a new era of informed and integrated healthcare.

■ ***Ian Duncan***
Hitchin, Herts

Natural Products Isolation. Methods in Biotechnology, Vol. 4

Edited by R.J.P. Cannell
Published by Humana Press (1998)
US$89.50, pp. 480
ISBN: 0-89603-362-7

The wide diversity of life and man's relentless quest for new medical and nutritional products has led to considerable interest in a vast array of natural substances. To write a book encompassing all of the techniques used to isolate such widely differing materials would be a daunting task and the editor has wisely concentrated on general practical approaches as opposed to detailing specific protocols.
Since the book is an amalgam of individual contributions there are some minor imbalances in the text. Whilst chromatography, rightly, is comprehensively covered, initial product recovery techniques are under-represented. A brave attempt is made to cover process scale-up in a single chapter, whilst such issues would be better served through discussion in the appropriate chapters, accompanied by a suitable basic mathematical treatment. Overall, however, the book successfully draws together a wide and disparate discipline and, as such, should serve as a useful introductory and reference text for researchers involved in developing techniques in this complex isolation area.

■ ***Steve Setford***
Cranfield University

Can Bacteria Cause Cancer?

By D.J. Hess
Published by New York University Press (1997)
US$26.95, pp. 223
ISBN: 0-8147-3561-4

The recognition that *Helicobacter pylori* is implicated in the aetiology of stomach cancer should have alerted the medical world to the potential role of bacteria in general in tumorgenesis. This fascinating book provides evidence to show that even common bacteria may cause cancer. Chapter 4 is particularly stimulating since, under the heading *Is it good science?*, the author asks whether or not the view that non-viral micro-organisms cause cancer is credible. Hess is an anthropologist and there are times (notably in chapter 5) when I suspect that most scientists would find his 'social science speak' incomprehensible. Having said this he has provided an excellent and unique account of the 'cancer germ' hypothesis. *Can Bacteria Cause Cancer?* should be read by all microbiologists who take an interest in non-mainstream aspects of their science. In addition, anyone involved in cancer research should open their minds and read this book.

■ ***Milton Wainwright***
University of Sheffield

The Complement System

Edited by K. Rother, G.O. Till & G.M. Hänsch
Published by Springer-Verlag GmbH & Co. KG (1998)
DM248.00/öS1811.00/sFr224.00/£95.50/US$159.00, pp. 564
ISBN: 3-540-61894-5

This is an updated and comprehensive review of the complement system by clinicians and scientists who have made significant contributions to this field. There are over 40 chapters. The authors discuss the structure and function of components of the complement cascade, their activation pathways and regulators. Its biological functions are considered in detail and there are reviews of the role of the complement system in the induction of the antibody response, processing of immune complexes, its relevance in host defence and strategies whereby micro-organisms evade its lytic consequences. The remainder of the book discusses individual complement component deficiencies. The chapter on *Methods of testing the complement system* is particularly useful. The references are both relevant and extensive. The abundant information in the text is helpfully summarized by the inclusion of numerous tables and figures. This is an admirable book. It is not for the uninitiated but for those scientists and clinicians working in this field it is an up-to-date and well referenced manual.

■ ***Bryan D. Williams***
University Hospital of Wales

Mycorrhiza Manual

Edited by A. Varma
Published by Springer-Verlag GmbH & Co. KG (1998)
DM148.00/öS1081.00/sFr135.00/£57.00/US$99.95, pp. 542
ISBN: 3-540-62437-6

This book presents up-to-date techniques for mycorrhizologists who, it has been emphasized, are providing new strategies in the development of biologically oriented agricultural strategies. In 34 chapters it covers a diverse range of techniques, including molecular methods (13 chapters), aspects of enzymology (5 chapters), plus immunology, protoplasting and cultivation of ectomycorrhizal fruit bodies. Arbuscular mycorrhizas receive considerable attention, ectomycorrhizas a little less, ericoid mycorrhizas are touched upon and there is even a chapter about actinorrhizas.
The general text is well laid out and divided into clear headings, including marginal headings, allowing the reader easy stepwise progression. Great effort has been made to describe protocols simply for a wide readership and this is aided by good use of illustrations (over 100, with only one poor one). Thorough attention has been paid to methodological detail and, importantly, many authors provide explanations or comment on adaptations of techniques, plus brief troubleshooting guides. The book will be extremely useful.

■ ***Lynne Boddy***
University of Wales, Cardiff
■ ***Damian Donnelly***
University of Sheffield

Mycotoxins in Agriculture and Food Safety

Edited by K.K. Sinha & D. Bhatnagar
Published by Marcel Dekker Inc. (1998)
US$175.00, pp. 520
ISBN: 0-8247-0192-5

The editors aimed to 'provide a detailed overview of mycotoxins in terms of theoretical, methodological, empirical, biosynthetic and regulatory considerations' and to focus on developments in the past 5 years or so. They have fallen a bit short of this ambitious aim. The coverage is uneven and the extensive citations in some chapters inevitably reflect a comprehensive treatment going back a long way. Two chapters focus on the toxins from single genera (*Fusarium* and *Alternaria*). The structures of these chapters are very different and information on other toxins, including the aflatoxins, is scattered throughout the book with occasional overlap. Despite these comments, I found much to admire in the book especially in the way it brings together disparate topics relating to mycotoxins and many of the chapters provide considerable detail. The book will be a useful reference work for scientists whose work embraces one aspect of mycotoxins but who need information in an area just outside of their immediate focus.

■ ***David Archer***
Institute of Food Research, Norwich

An Introduction to Polysaccharide Biotechnology

By M.P. Tombs & S.E. Harding
Published by Taylor & Francis (1997)
£29.95, pp. 256
ISBN: 0-7484-0516-X

This book is aimed at university students of biotechnology and brings together a wealth of information that is otherwise inaccessibly scattered around the scientific literature. It focuses on real biotechnological applications, but provides a very solid scientific background in the physical chemistry of polysaccharides. The quality and relevance of the material is very high and will interest a broad range of readers, though microbiologists might find the microbiological inaccuracies and occasional confusion between plants and microbes a little aggravating. I.W. Sutherland's *Biotechnology of Microbial Polysaccharides* provides a useful counterbalance. The book is generally well planned and illustrated, but the attempt at a general introduction to biotechnology in the first chapter would not be adequate for the target audience. Several illustrations reproduced from published sources have inadequate legends and the quality of the writing is decidedly patchy. Nevertheless, it is highly recommended as a source book.

■ ***Ian Hancock***
University of Newcastle

Dying to live: how our bodies fight disease

By M.D. Kendall
Published by Cambridge University Press (1998)
£17.95, pp. 196
ISBN: 0-521-58479-5

Writing for the general reader about the immune response to infection is an immense challenge. Unfortunately this book illustrates all the potential pitfalls and more. Attempts to simplify language and concepts lead to general statements that are misleading or wrong, and the tone is often patronizing. There is no clear structure to the book (perhaps recognized by the inclusion of a figure that attempts to illustrate how the chapters relate to each other), and the text is rambling and repetitive. I could not recommend this book to any possible reader.

■ ***Lucinda Hall***
St Bartholomew's and the Royal London School, London

The Coxsackie B Viruses. Current Topics in Microbiology and Immunology, Volume 223

Edited by S. Tracy, N.M. Chapman & B.W.J. Mahy
Published by Springer-Verlag GmbH & Co. KG (1997)
DM195.00/öS1423.50/SFr176.00/£75.00/US$129.95, pp. 311
ISBN: 3-540-62390-6

Always overshadowed by their more notorious cousins, the polioviruses, coxsackie B viruses (CVB) have been relatively little studied and have not been brought under control through the development of vaccines or drugs. This is unfortunate since this group of viruses is both interesting scientifically and is the cause of significant human health problems. The six serotypes of CVB are associated with a range of clinical conditions, including pleurodynia, aseptic meningitis, acute myocarditis and pericarditis, and possibly juvenile onset insulin-independent diabetes mellitus. This book contains chapters from many specialist CVB researchers and covers history and epidemiology, association with disease, genetic relationships to related enteroviruses, and molecular biology and replication. It is the most comprehensive book on CVB to date and will be highly welcomed by picornavirologists working with CVB or related members of the family. With the increasing evidence that CVB are a significant cause of human heart disease, it is likely that the viruses will receive more attention in the years ahead. This book will form a good starting point for virologists motivated to investigate this area or those simply wishing to know more. Volume 223 is in keeping with this excellent series.

■ ***Jeff Almond***
University of Reading

Pathology of Emerging Infections

Edited by C.R. Horsburgh Jr & A.M. Nelson
Published by ASM Press/Blackwell Science (1997)
£53.00, pp. 317
ISBN: 1-55581-120-5

The reader will sense from the first two chapters that pathology of infectious disease is a traditional discipline that has recently embraced immunological and molecular technologies, allowing rapid diagnosis and characterization of a wide variety of infectious agents. Many of these agents are very new viral (human herpesvirus 8, Ebola, hepatitis C) and non-viral (*Helicobacter pylori*, *Borrelia burgdorferi* (Lyme), *Cryptosporidium parvum*) pathogens. The fusion of traditional fixation and staining methods with high resolution detection methods allows detailed characterization of both the infectious agents' life cycle and also the host response to these processes. Evidence of these advances is beautifully illustrated in colour plates that follow each chapter, in some cases with photographs of clinical presentation of disease too. The text is clear, accurate and has margin notes that guide the reader to key sections. Two adverse comments are that authorship, and therefore content, tend to reflect CDC interests 'which may be an appropriate guide to us all' and, second, some key 'emerging' agents (*E. coli* O157, enzootic retroviruses, *Chlamydia pneumoniae*) are barely mentioned. A valuable reference particularly for pathologists who need to know what could be coming next.

■ ***Eddie Blair***
GlaxoWellcome, Stevenage

Drugs in HIV and AIDS, Second Edition

By A. Palfreeman, M. Youle & C. Farthing
Published by John Wiley & Sons Ltd (1998)
£16.99, pp. 115
ISBN: 0-471-97063-8

This is the second edition of a handy pocket-sized book summarizing approaches to drug treatment in HIV and associated infections. It contains helpful practical information about currently available therapies and how to use them. As the authors themselves state, it is likely to become out-of-date very quickly in a specialty moving at the rapid pace of HIV treatment. However, in certain areas, the information provided is not entirely up-to-date. In the chapter on chest disease, the principal method of diagnosis of *Pneumocystis carinii* infection is said to be 'methenamine silver staining' or by polymerase chain reaction. The former has been superseded by fluorescent antibody detection and the latter technique is not widely or commercially available. Despite this, medical students and junior doctors who do not see many patients with HIV infections will benefit from this short guide.

■ ***Sheila Burns, City Hospital, Royal Infirmary of Edinburgh***

Reoviruses I: Structure, Proteins and Genetics/Reoviruses II: Cytopathogenicity and Pathogenesis. Current Topics in Microbiology and Immunology, Vols. 233/I & 233/II

Edited by K.L. Tyler & M.B.A. Oldstone
Published by Springer-Verlag GmbH & Co. KG (1998)
Vol. I: DM216.00/öS1,577.00/SFr195.00/Fr814.00/£83.00/US$139.00, pp. 223
ISBN: 3-540-63946-2
Vol. II: DM202.00/öS1,475.00/SFr182.00/Fr761.00/£77.50/US$129.00, pp. 187
ISBN: 3-540-63947-0

These two volumes review reovirology at a very high standard. The field is very well investigated with regard to genome composition, particle structure, replication and, last but not least, molecular genetics. The segmented nature of the reovirus genome for which firm gene protein assignments have been made and the ability of these viruses to form reassortants readily in doubly infected cells has allowed the study of many of the biological activities and the dissection of different genome functions with regard to their contribution to pathogenesis. The latter has been pursued in an exemplary way by the group of the late Bernard Fields and his work has been of great influence for other areas of virology.
The two volumes unite many senior researchers in this field who understand their contributions as part of a posthumous Festschrift for Bernard Fields after his untimely death in 1995. This referee wishes wide distribution to these two excellent volumes which are of interest not only to the community of virologists, but also to immunologists, biochemists and physicians with an interest in molecular pathogenesis.

■ ***Ulrich Desselberger***
PHLS, Addenbrooke's Hospital, Cambridge

Technology of Bottled Water. Sheffield Food Technology, Vol. 3

Edited by D.A.G. Senior & P. Ashurst
Published by Sheffield Academic Press (1998)
£75.00, pp. 293
ISBN:1-85075-867-0

The 1990s have seen the rise and rise of bottled waters, be they designer brands or life-saving relief supplies. They are an important part of modern life and will always be with us. Despite it being recognized that bottled water may be the only water that is safe to drink in many parts of the world, there is still a tendency amongst some observers (some of whom should know better) to disparage it. It is sometimes not appreciated that there is a world of difference microbiologically between heavily chlorinated tap water and a natural mineral water with its natural heterotrophic flora. It is therefore a pleasure to welcome an authoritative textbook on all aspects of bottled water to set matters straight. In addition to chapters on bottling plant, water treatment and quality management that will be relevant to the microbiologist, there are also definitive sections on the microbiology of both natural mineral water and treated bottled water. Essential reading for anybody working on the microbiology of drinking water of all kinds.

■ ***Mike Hurst***
Watermark

The Development of Gene Therapy in Europe and the United States: A Comparative Analysis. STEEP Special Report No 5

By P. Martin & S.M. Thomas
Published by Science Policy Research Unit, University of Sussex (1996)
£150.00, pp. 165
Academic/Public Sector Price £20.00
ISBN: 0-903622-78-5

This ring-bound book, published in December 1996, is of very great value but unfortunately, I guess, only to a fairly limited audience. This said, the book succeeds in several ways. First, it is a reference manual to the big and so-so big 'players' in the 'fledgling' field of gene therapy – although this book ascribes the term 'genetic therapy' to Tatum in 1966. Second, it is a very useful guide to how the USA and European countries have sought to oversee and regulate gene therapy studies in response to, or perhaps in spite of, immense public concern. Perhaps there is some guidance for those currently involved in similar activities in relation to BSE. Finally, it is extremely well researched and the information it contains is very accurate. The authors have obviously investigated their topic very well and managed to espouse it in easily understood text. For all these reasons it is a definitive guide for all – lay public to distinguished scientist – who seek to know more about what gene therapy actually means right now, both here in Europe and 'across the pond'.

■ ***Eddie Blair***
GlaxoWellcome

Diary

march 99

EARLY HIGH THROUGHPUT ADME AND TOXICOLOGY STUDIES

Basel, Switzerland
9–10 March 1999

CONTACT: Anja Knauer, IBC UK Conferences Ltd, Biomedical Division, Gilmoora House, 57–61 Mortimer Street, London W1N 8JX (Tel. 0171 453 5404; Fax 0171 631 3214; e-mail anja.knauer@ibcuk.co.uk; http://www.ibc-uk.com/)

INFORMATICS AND COMPUTING TO SUPPORT EARLY ADME AND TOXICOLOGY STUDIES

Basel, Switzerland
11 March 1999

CONTACT: Anja Knauer, IBC UK Conferences Ltd, Biomedical Division, Gilmoora House, 57–61 Mortimer Street, London W1N 8JX (Tel. 0171 453 5404; Fax 0171 631 3214; e-mail anja.knauer@ibcuk.co.uk; http://www.ibc-uk.com/)

SIXTH SYMPOSIUM ON RENEWABLE RESOURCES FOR THE CHEMICAL INDUSTRY

together with

THE FOURTH EUROPEAN SYMPOSIUM ON INDUSTRIAL CROPS AND PRODUCTS

Bonn, Germany
23–25 March 1999

CONTACT: Sarah Wilkinson, Renewable Resources/ICP Secretariat, Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB (Tel. 01865 843691; Fax 01865 843958; e-mail sm.wilkinson@elsevier.co.uk; http://www.elsevier.nl/locate/icp99)

GLOBAL PHARMACEUTICAL SUPPLY CHAIN

Kensington Palace Thistle, London
25–26 March 1999

CONTACT: Anja Knauer, IBC UK Conferences Ltd, Biomedical Division, Gilmoora House, 57–61 Mortimer Street, London W1N 8JX (Tel. 0171 453 5404; Fax 0171 631 3214; e-mail anja.knauer@ibcuk.co.uk; http://www.ibc-uk.com/)

ANNUAL LIGHT MICROSCOPY MEETING

London
30 March 1999

CONTACT: Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; e-mail meetings@rms.org.uk; http://www.rms.org.uk)

april 99

INSTITUTE OF PHYSICS 1999 CONGRESS: WORLD OF PHYSICS – CREATING THE FUTURE

University of Salford
12–15 April 1999

CONTACT: Fiona Tatteossian, Institute of Physics, 76 Portland Place, London W1N 3DH (Tel. 0171 470 4800 ext. 4839; Fax 0171 470 4848; e-mail physics@iop.org; http://www.iop.org)

3D AND CONFOCAL MICROSCOPY CONFERENCE

EMBL Heidelberg
12–15 April 1999

CONTACT: Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; e-mail meetings@rms.org.uk; http://www.rms.org.uk)

DISINFECTANT USE AND VALIDATION IN THE PHARMACEUTICAL INDUSTRY

London
14 April 1999

CONTACT: Management Forum Ltd, 48 Woodbridge Road, Guildford, Surrey GU1 4RJ (Tel. 01483 570099; Fax 01483 536424; e-mail management_forum@psilink.co.uk; http://www.management-forum.co.uk)

MICROSCOPY OF BIOMATERIALS III MEETING

QMWC London
14 April 1999

CONTACT: Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; e-mail meetings@rms.org.uk; http://www.rms.org.uk)

THE LEEDS APPLIED FOOD MICROBIOLOGY COURSE

Weetwood Hall, Leeds
19–22 April 1999

CONTACT: Ian Mallinson, Leeds Environment Department, Leeds City Council, 155, Kirkstall Road, Leeds, LS4 2AG (Tel. 0113 2476290; Fax 0113 2476282)

may 99

ESVV SYMPOSIUM ON ANIMAL INFLUENZA VIRUSES

'het Pand', Onderbergen 1, 9000 Gent, Belgium
16–18 May 1999

CONTACT: Dr Kristien Van Reeth, Lab of Veterinary Virology, Faculty of Veterinary Medicine, Gent University, Salisburylaan 133, 9820 Merelbeke, Belgium (Tel. +32 9 264 73 69; Fax +32 9 264 74 95; e-mail: kristien.vanreeth@rug.ac.be)

june 99

CANCER RESEARCH CAMPAIGN BEATSON INTERNATIONAL CANCER CONFERENCE: INVASION AND METASTASIS

Glasgow
27–30 June 1999

CONTACT: Tricia Wheeler (Tel. 0141 942 0855; Fax 0141 942 6521; e-mail: t.wheeler@beatson.gla.ac.uk; http://www.beatson.gla.ac.uk/beatson/conf.)

july 99

FEG ELECTRON MICROSCOPY MEETING

Oxford
12 July 1999

CONTACT: Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; e-mail meetings@rms.org.uk; http://www.rms.org.uk)

LIGHT MICROSCOPY SUMMER SCHOOL

Leeds
19–23 July 1999

CONTACT: Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; e-mail meetings@rms.org.uk; http://www.rms.org.uk)

august 99

CELLS AND MATERIALS 'BONE AND SOFT TISSUE BIOMATERIAL INTERACTIONS'

Davos, Switzerland
22–24 August 1999

CONTACT: Dr Geoff Richards, AO ASIF Research Institute, Clavadelerstrasse, CH7270 Davos Platz, Switzerland (Tel. +41 81 4142 397; Fax +41 81 4142 288; e-mail geoff.richards@ao-asif.ch/events/other/smi/index.html)

september 99

HUMAN FUNGAL PATHOGENS. FUNGAL DIMORPHISM AND DISEASE

Granada, Spain
4–8 September 1999

CONTACT: Dr Josip Hendekovic, European Science Foundation, 1 quai Lezay-Marnésia, 67080 Strasbourg Cedex, France (Tel. +33 3 88 76 71 35; Fax +33 3 88 36 69 87; e-mail euresco@esf.org; http://www.esf.org/euresco)

MICROBIOLOGY TECHNIQUES. A TWO-DAY LABORATORY COURSE

Hatfield, Hertfordshire
6–7 September 1999

CONTACT: Dr Virginia Bugeja, Dept of Biosciences, University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB (Tel. 01707 284590; Fax 01707 286137; e-mail v.bugeja@herts.ac.uk; http://www.herts.ac.uk/natsci/STC)

PROTEIN TECHNIQUES. A TWO-DAY LABORATORY COURSE

Hatfield, Hertfordshire
6–7 or 13–14 September 1999

CONTACT: Prof. John Walker, Dept of Biosciences, University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB (Tel. 01707 284546; Fax 01707 284510; e-mail j.m.walker@herts.ac.uk; http://www.herts.ac.uk/natsci/STC)

NUCLEIC ACID TECHNIQUES. A THREE-DAY LABORATORY COURSE

Hatfield, Hertfordshire
8–10 or 15–17 September 1999

CONTACT: Dr Virginia Bugeja, Dept of Biosciences, University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB (Tel. 01707 284590; Fax 01707 286137; e-mail v.bugeja@herts.ac.uk; http://www.herts.ac.uk/natsci/STC)

FLOW CYTOMETRY COURSE

Sheffield
13–17 September 1999

CONTACT: Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; e-mail meetings@rms.org.uk; http://www.rms.org.uk)

MOLECULAR STRATEGIES FOR DRUG DISCOVERY AND DESIGN. A ONE-DAY LECTURE MEETING

Hatfield, Hertfordshire
15 September 1999

CONTACT: Dr Ralph Rapley, Dept of Biosciences, University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB (Tel. 01707 285097; Fax 01707 286137; e-mail r.rapley@herts.ac.uk; http://www.herts.ac.uk/natsci/STC)

april 2000

MICRO 2000

London
11–13 April 2000

CONTACT: Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (Tel. 01865 248768; Fax 01865 791237; e-mail meetings@rms.org.uk; http://www.rms.org.uk)

Comment

The way forward for British science

Peter Cotgreave

It never ceases to amaze me how frequently the media manage to confuse the various microbial agents of disease. At the beginning of a paragraph, they will refer to a bacterium, but thirty seconds later, the same thing will be called a virus.

When I challenge people about this sloppy reporting, I am often told that I am being pedantic; I am a scientific train spotter. The people who say these things are sometimes surprised at the vehemence of my response, which is simple. If you want answers to questions about BSE, AIDS and the deadly effects of some strains of *E. coli*, then you need to know about prions, viruses and bacteria. That means three well-funded areas of research, and if people can't see the difference, they won't be inclined to invest in them.

In fact, of course, what the country needs is proper investment in a broad Science Base, with strong research teams in a wide diversity of disciplines. Such a Science Base is crucial to the well-being of our nation.

So Save British Science exists to communicate a proper appreciation of the cultural and economic benefits of science, technology and engineering. Because we are a small organization, we concentrate our efforts on a small group of people with most influence – Government ministers, their civil servants and advisers, businessmen and the media.

Our principal aim is to increase levels of Government investment in research. Fifteen of the UK's competitors invest a greater proportion of their wealth into their science than we do, including Japan, Germany and France, but also Iceland, Belgium and Finland.

Our main message is that the funding of science should not be seen as expenditure, but as investment in the future health, environment and quality of life of the British people. The healthier the Science Base is now, the stronger society will be in five or ten years' time. The great starting point is that Britain has a long tradition of successful and innovative science, and its scientific output is the most efficient in the world. The British taxpayer gets more science for each pound spent than anyone else in the world.

In fifty years' time, the UK can be in one of two positions. One option is to slip behind Germany, Japan and the USA and look back to the days when we punched above our weight. The other is to give decent levels of funding to our science and capitalize on the potential we so clearly have.

The message that SBS often finds it hardest to get across is that science is an investment even when nobody can currently see the use of it. History is littered with examples to prove that great breakthroughs come from 'blue-skies' research driven by nothing but the curiosity and fascination of some clever scientists. Watson and Crick, for example, discovered the DNA double helix when they were supposed to be working on something else. Joseph Priestley discovered oxygen by accident; he could not even recall why he had performed the crucial experiment.

Campaigning for science in this country is hard work and we cannot be complacent just because the current Government has found some new money. In America, scientists take their Congressmen seriously and their politicians take the scientists seriously. The new national plan for science, drawn up by the House of Representatives, extols the virtues of significant funding for basic, curiosity-driven science.

In this country, Save British Science has done a good job at forcing politicians to take science seriously. To keep up the pressure, so that this and future Governments continue to recognize that their scientists are one of their finest assets, the Save British Science Society needs more members. If you are interested in our work, please contact me.

We happen to live on a pretty fascinating planet in a wonderful universe. I wouldn't want to live anywhere else, because science provides me with a way of thinking about things that keeps me constantly interested. The difference between a bacterium and a virus could provide ten thousand years of study. More people with power and influence need to understand that, and SBS is there to tell them.

● ***Dr Peter Cotgreave, Director Save British Science***
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● Please note that views expressed in *Comment* do not necessarily reflect official policy of the SGM Council.

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