MICROBIOLOGY TODAY

QUARTERLY MAGAZINE OF THE SOCIETY FOR GENERAL MICROBIOLOGY VOLUME 30 AUGUST 2003

Biodeterioration – Things that go rot in the night

Everything you ever wanted to know about dry rot

Lichens – agents of monumental destruction

Conservation by bacterial biomineralization

The role of SRB in metal corrosion

Pilzkrieg: the German wartime quest for penicillin

SARS update

Contents

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

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

Editor
Dr Meriel Jones

Editorial Board
Professor Dave Kelly
Professor Tony Nash

Managing Editor
Janet Hurst

Production Editor
Ian Atherton

Assistant Editor and Book Review Manager
Janice Meekings

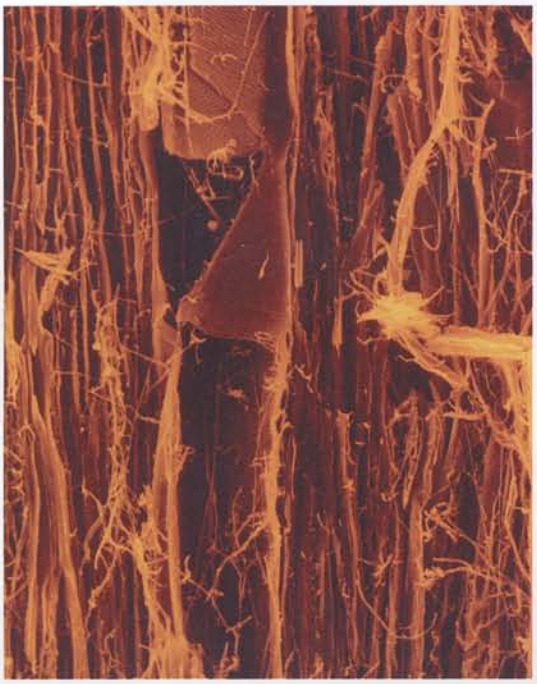
Contributions
These are always welcome and should be addressed to the Editor (c/o SGM Headquarters).

Copy Dates
Last dates for receipt of copy at Marlborough House are:
General Copy
November 2003 issue 1 Sept
February 2004 issue 8 December
Advertisements (CRC)
November 2003 issue 29 Sept
February 2004 issue 19 January

Advertisements
All enquiries should be sent to: Dominic Young, Hardy Advertising, Granville House, 112 Bermondsey Street, London SE1 3TX
Tel. 0207 378 1579
Fax 0207 378 6421
email dominic@hardyadvertising.co.uk

Subscriptions 2003
NON-MEMBERS
Microbiology Today £50.00 (US$85.00)
MEMBERS
All members receive *Microbiology Today*. In addition they may take any of the Society's journals.
Ordinary Member
Membership Subscription (inc. *Microbiology Today*) £43.00 (US$74.00)
Microbiology/*JGV*/*IJSEM* £78.00 (US$145.00)
JMM £40.00 (US$71.00)
Student or Retired Member
Membership Subscription (inc. *Microbiology Today*) £20.00 (US$35.00)
Microbiology/*JGV* £37.00 (US$70.00)
IJSEM £78.00 (US$145.00)
JMM £40.00 (US$71.00)
Undergraduate or School Member
Membership Subscription (inc. *Microbiology Today*) £10.00
Corporate Member
Membership Subscription (inc. *Microbiology Today*) £500.00
US Office of Publication: *Microbiology Today*, c/o Mercury Airfreight International Ltd, 365 Blair Road, Avenel, NJ07001, USA. Postmaster: send US address corrections to *Microbiology Today* c/o this address.

 ISSN: 1464-0570



Above: A scanning electron micrograph of the dry-rot fungus, *Serpula lacrymans*, in domestic plywood. *Dr Jeremy Burgess/ Science Photo Library*

Vol. 30, Part 3, August 2003

In this issue we focus on biodeterioration and biodegradation. Microbes can break down a great range of materials and often their action is unwanted, unsightly and uneconomic. Glyn Morton reviews the different types of deterioration on pp. 103–106. Biodeterioration can also mean business, as Richard Smith describes on p. 118.

The harmful effects of microbes on buildings cause considerable problems. Dry rot of wood is the subject of John Palfreyman and Nia White's article on pp. 107–109, whilst Mark Seaward looks at the way lichens can attack stonework, damaging historic buildings in the process (pp. 110–112). Conversely, bacteria have the potential to reverse the decay of monuments, as Brunella Perito and Giorgio Mastromei describe on pp. 113–114.

The corrosion of metals in an anaerobic environment is usually caused by sulfate-reducing bacteria (SRB) and Iwona Beech explains the chemical processes involved on pp. 115–116.

Turning back in time, on pp. 120–123 Gilbert Shama recounts the story of the Germans' unsuccessful efforts to produce bulk quantities of penicillin in World War II.

Found to be caused by a coronavirus, SARS has been hitting the headlines for the past 4 months. On pp. 124–125 Faye Jones chronicles the progress of the outbreak, whilst in Comment on p. 152 Dave Cavanagh points out that considerable expertise on coronaviruses already exists amongst the veterinary community for SARS researchers to draw on.

These articles appear in addition to all the regular features and reports of Society activities.

Articles

Regular Features

Other Items

SGM website makeover www.sgm.ac.uk

In recent months a dedicated small team of staff at Marlborough House, led by Systems Manager Duncan McGarva, have been beavering away to improve the Society's website. Originally launched in 1997 when it was designed and produced entirely in-house by Duncan, the website has proved to be a vital means of communicating information about the Society and its activities to the microbiological community worldwide. Because many other sites link to our pages, its ranking is high in the search engines. Hits on the pages, particularly for meetings and journals, are many and constant, and over the years the site has been refined and re-organized (see http://web.archive.org/web/*/http://www.socgenmicrobiol.org.uk). New features such as on-line booking forms for meetings and on-line submission of abstracts have been introduced. However, as we entered the third year of the new millennium, the design was beginning to appear dated, and the decision was made to have a complete new look and to review the content and arrangement of the web pages.

After some research, professional web developers bn2web Ltd were selected to design the new SGM site and convert the required content on the old website to the new format. A remit was submitted to the company and after many hours of discussion about exact requirements, some provisional designs for the home page and other sections were made available. These were then the subject of a spirited debate by the Marlborough House team, but eventually a consensus was achieved due to the exertion of managerial authority by Executive Secretary, Ron Fraser. With Duncan as the conduit of information to bn2web, modifications were made to the design. Then the work on converting the content by Eric Clack and his colleagues began.

As the new site began to take shape, it was constantly reviewed by SGM staff and amendments and corrections were made both in-house (by Duncan, Jane Westwell and Ian Atherton) and by bn2web. The project inevitably took longer than anticipated, as the research, development and checking in particular made a lot of work, but the site went live on Thursday 29 May to the great relief of all involved.

How does the new site differ from the old?

Of course it has a completely new look, although the SGM 'house' colours of dark blue and orange have been retained. There are lots more pictures; consistency and navigation have been greatly improved. The navigation bar appears down the left-hand side on every page (although it does not print out) and clicking on the orange SGM logo in the top left-hand corner returns the user to the home page. New features include a site map and a search facility. Much of the information has been re-arranged to make it easier to find and extra material has been included in some sections.

Current information is available directly from the home page where the latest issue of *Microbiology Today* can be accessed and the Noticeboard, aimed mainly at members, lists present society initiatives and activities, such as the latest meeting, new grant schemes and the availability of recent publications. Newsdesk also runs off the home page, providing an overview of microbiological stories that have appeared in the press that week and more in-depth reviews of topical issues such as SARS. SGM media releases, press contact details and responses to consultations can also be accessed.

An exciting new feature is the 'Micro-encyclopedia', the result of much work by Ron and Ian, which by organizing the articles in past issues of *Microbiology Today* by subject, provides an excellent microbiology resource for the public. The links page has also been re-arranged by theme to make it more user-friendly.

Information about the Society (including a redrawn map showing how to find Marlborough House), its Council, Group Conveners and staff, is available via the 'about SGM', 'Who's Who' and 'Contact Us' buttons; there are also direct links to the SGM's stand-alone sites on microbiology education and careers from the navigation bar.

Most of the key information about SGM journals now resides on the HighWire site, but the new website leads smoothly into those pages, whilst providing details of subscriptions and other essential facts about publications. The *Microbiology Today* pages have been greatly expanded and information is also available on SGM symposium volumes.

On the meetings front, users will find a great improvement in the layout of information, and those seeking to join SGM will locate the necessary membership forms quickly and easily. Navigation of the grants pages has been enhanced.

Feedback on the new site is welcome, so why not point your browser to www.sgm.ac.uk and explore the pages. Please send your comments and suggestions to web.admin@sgm.ac.uk

● *Janet Hurst, Deputy Executive Secretary*

Things that go rot in the night – a review of biodeterioration

Glyn Morton

'Putrefaction
is the End
Of all that nature
doth Entend'
Herrick

Micro-organisms have a simple approach to life; they use whatever is available as a food source, attach themselves to practically all surfaces, multiply and build up biomass. Everyone is familiar with the phenomenon of rotting, the natural decay and recycling of materials by a wide range of life forms, including micro-organisms. This process is termed biodegradation and it is perceived as a beneficial or positive process. Biodeterioration may be defined as 'the deterioration of materials of economic importance by micro-organisms'; it is perceived as a deleterious or negative process. Biodeterioration has been classified as follows:

Mechanical biodeterioration. This occurs when the material is damaged as a direct result of the physical activity of an organism, such as its movement or growth. An example of this kind of biodeterioration is the damage caused to electrical cabling as a result of insect or rodent attack.

Chemical assimilatory biodeterioration. This is perhaps the most common form of biodeterioration. It occurs when a material is degraded for its nutritional value. The breakdown of cellulosic materials such as wallpaper by cellulolytic fungi is an example.

Chemical dissimilatory biodeterioration. This occurs when a material is damaged as a result of the production and release of metabolic products that may corrode, pigment or toxify the material. The poisoning of grain by mycotoxins, and the release of pigments into plastic films are examples of this process.

Soiling. This visible form of biodeterioration occurs when the mere presence of an organism or its excrements renders the product unacceptable. The function of the material may be impaired by the presence of the organisms, as in the fouling of ships' hulls by barnacles and algae.

It is essential to appreciate that more than one of these processes, or indeed all of them may be occurring at the same time.

Materials of economic importance known to be subject to biodeterioration include:

- Stored agricultural products
- Wood and allied constructional materials
- Pharmaceuticals and cosmetics
- Polymers, rubbers and plastics
- Glass
- Archival material
- Pulp paper
- Textiles and leather
- Fuels and lubricants
- Metals
- Paints
- Stone, concrete and buildings
- Adhesives and sealants

The list is extensive and it includes most of the industrial materials that readily come to mind. It is difficult to accept that some of these materials (glass, metal, stone) are susceptible to microbial attack. It is beyond the scope of this article to discuss all the materials listed. Therefore, selected examples of microbial biodeterioration familiar to the author will be reviewed.

The role of biofilms

Biofilms are an extremely important and integral part of biodeterioration.

The removal of those biofilms which may be unsightly or considered to be a hazard to health can be a costly and time-consuming business. When the colonization of the surface of any material occurs, the term biofilm is invariably used. At one time this term was confined to surfaces in constant contact with water, i.e. at the solid/liquid interface. The definition has now been extended to any interface, i.e. air/solid, liquid/liquid and air/liquid, where growth of micro-organisms occurs. To a microbiologist a biofilm represents a zone where the deleterious effects brought about by the presence of micro-organisms and their extracellular metabolites are concentrated or focussed. Slime production, the result of polymeric materials produced by a wide variety of micro-organisms – bacteria, fungi and algae – is associated with biofilms. For many years workers in industry have recognized the problems caused by slimes that develop in process machinery, in storage tanks and cooling towers and on many surfaces in contact with liquids (Fig. 1).

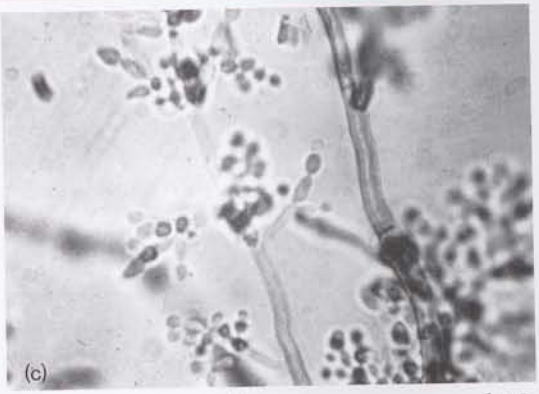
ABOVE (TOP):
Fig. 1. Bacterial slime from within a pipeline.
COURTESY JOHN GILLATT, THOR UK LTD.

ABOVE (BOTTOM):
Fig. 2. A piece of timber with brown rot.
COURTESY G. MORTON

Examples of the biodeterioration of materials of economic importance

Wood

The rotting of wood is probably the most well known example of decay caused by fungi. For practical purposes the type of rot derives its name from the appearance and integrity of the attacked wood. Chemically, wood is made up mainly of cellulose and lignin. When both of these components are consumed by a fungus, the wood becomes lighter in colour and the term 'white rot' is used. Some fungi consume more cellulose than lignin and the wood becomes brown in colour, hence the term 'brown rot' (Fig. 2). Other types of decay include wet



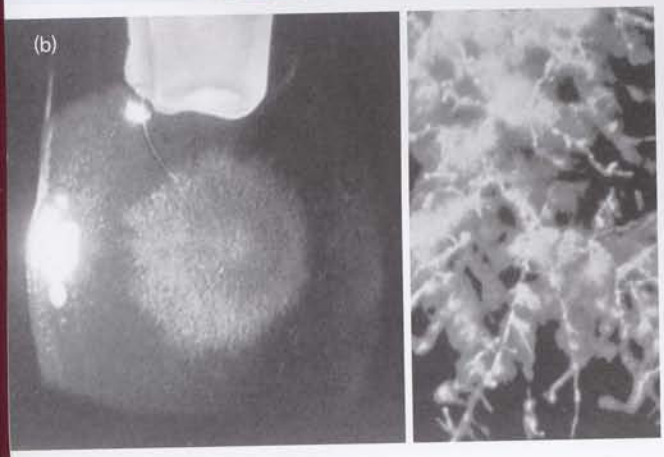
BELOW:
Fig. 3. (a) Small sample of deteriorating PVC roofing material with fungal (green) and actinomycete (red) pigmentation (COURTESY G. MORTON). (b) Fungal colonization of a soft plastic contact lens. The image on the right shows the fungal hyphae within the lens material (COURTESY ADVANCE MEDICAL OPTICS LTD).

RIGHT:
Fig. 4. (a) Contaminated diesel fuel. (b) Lacing at the fuel water interface. (c) *Hormoconis resinae*. COURTESY G. MORTON

rot, soft rot and staining. Brown, white and wet rots are caused by fungi that produce large, noticeable fruiting bodies (macrofungi), whilst soft rot and staining are mainly caused by microfungi. All wood needs to be wet before it can rot, yet decayed wood sometimes looks dry (especially within buildings) when it is infected with dry rot. As John Palfreyman and Nia White describe on pp. 107 the fungi responsible for this condition, such as *Serpula lachrymans*, are able to import water from other regions of the infected timber, via special filaments.

Plastics

Plastics possess a broad range of chemical and physical properties that may be tailored to meet the particular requirements of industry. Specifically, they have been formulated for durability to resist weathering and therefore to resist microbial biodeterioration. Because plastics are both cheap and relatively easy to produce they have replaced traditional materials such as wood, metal and rubber in a broad range of industrial applications. Some of the materials that are classified as plastics are readily attacked by micro-organisms. These include natural rubber and synthetic rubbers, regenerated and modified celluloses, polyesters and polyurethanes. Commercially produced plastics, including polyethylene, polypropylene, polystyrene, polyvinyl chloride and the polyamides (nylons) are generally considered to be inert, but there is evidence to suggest that they are susceptible to microbial attack under certain conditions. Rubbers and plastics contain a wide variety of additives that are susceptible to damage by microbes. These include plasticizing compounds such as adipates, ricinolates and sebacates which are used to confer flexibility to rigid plastics such as PVC. The effects are often severe (Fig. 3a) and in some cases unexpected. (Fig. 3b).



Micro-organisms in fuels, lubricants and coolants

For any micro-organism to grow actively in a hydrocarbon it must have water and a supply of nutrients. Micro-organisms are able to grow over a range of pH, temperature and oxygen values. They can utilize a wide range of organic and inorganic nutrients, and they also produce extracellular emulsifying agents which enable them to come into close contact with the hydrocarbon droplets. It is not surprising that they grow actively in formulations containing hydrocarbons. The problems caused by micro-organisms include bioslimes, a loss of useful additives and the formation of metabolic products, which indirectly contribute to corrosion problems.

Fuels. In the presence of water and other nutrients present in fuel systems, diesel fuel and aviation kerosene will support the growth of a range of bacteria and fungi. One particular fungus, *Hormoconis resinae* or the 'kerosene fungus', flourishes in aviation fuel which is screened regularly for the presence of this, and other unwelcome microbial passengers (Fig. 4).

Metal-working fluids. Metal-working fluids, or cutting fluids, are used in industry to facilitate machining processes. They are needed to prolong tool life, improve surface finish, remove swarf, reduce frictional heat between the tool and the chip, and to reduce power consumption. Any reduction in the efficiency of these functions constitutes a problem. Metal working fluids are classified according to their chemical composition and fall into four major groups: neat oils, oil-in-water emulsions, 'semi-synthetic' oil-in-water emulsions and chemical solutions. Oil-in-water emulsions are the

most widely used industrial cutting fluids. Neat oils are not usually considered to be susceptible to biodeterioration, since free water is seldom present. The growth of micro-organisms (mainly bacteria) in oil-in-water emulsions, can result in emulsion instability, lowering of pH, production of foul odours, the formation of stable emulsions, and increased corrosive activity. Microbial growth (mainly of fungi) in semi synthetic fluids and chemical solutions results in lowering of pH, production of fungal biomass and foul odours. This microbial invasion can be readily appreciated when one considers that commonly employed additives in modern metal-working fluids can be biodegraded by micro-organisms. These include emulsifiers, extreme pressure additives, and corrosion inhibitors. Of particular concern is the fact that pathogens have been isolated from metal-working fluids, often co-existing with non-pathogens, and transmitted in 'mists' generated by the machines.

Biocorrosion of concrete and stone

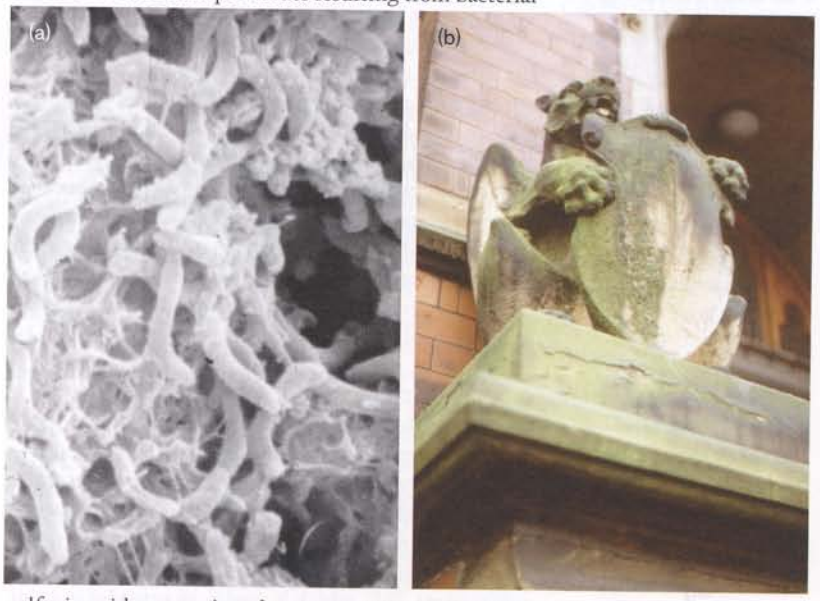
Biocorrosion can be defined as any corrosive effect on the surface of a material caused by micro-organisms. Biologically influenced corrosion (BIC), microbial corrosion (MC) and microbially influenced or induced corrosion (MIC), are among the terms used to describe biological corrosion of metals. The mechanisms by which biofilms contribute to corrosion are influenced by the availability of oxygen in the environment. Under aerobic conditions, localized biofilm deposits can cause the formation of anodic and cathodic areas on the surface of a metal. These areas become a series of differential chemical cells, each inducing the transfer of electrons with loss of cations causing pitting. Sulfur-oxidizing bacteria produce sulfuric acid in quantities sufficient to bring about the corrosion of metals. Under anaerobic conditions sulfate-reducing bacteria (SRB) are the major cause of corrosion in low oxygen or oxygen-free environments (Fig. 5a), as described in more detail by Iwona Beech on p. 115.

The surfaces of stone or concrete are readily colonized by micro-organisms (Fig. 5b). The decay of these surfaces is dependent on the production of corrosive metabolites.

Since the introduction of Portland cement almost 50 years ago, concrete has become one of the most widely used synthetic materials within the construction industry. It is composed of cement powder, water and aggregates of various sizes, such as sand or gravel. The main constituents of cement powder are lime, silica, alumina and iron oxide. Upon curing, the cement paste hydrolyses to form hydrated calcium silicates (C-S-H gels) and Portlandite [$Ca(OH)_2$]. The arrangement of these crystals allows channels to form within the concrete structure. The formation of these channels within the concrete permits the capillary action of water, which may contain micro-organisms. Thus, as water permeates deeper into the concrete, fissures are formed, allowing the deposition of organic material and the further ingress of micro-organisms. Workers in the 1940s and 1950s established that thiobacilli were the causative agents of MIC of concrete structures in sewers due to the production of sulfuric acid. This acid reacts with the calcitic binding material of the concrete causing its destruction. Two other sulfur compounds are detected on sewer walls, namely sulfur dioxide and thiosulfate. Thiosulfate is a reaction product of sulfur dioxide with molecular sulfur and forms a good substrate for thiobacilli.

Freshly prepared concrete has a pH of 12–13 compared to the highly acidic pH (2·5–0·5) of corroded concrete. It is considered appropriate to view the presence of *Acidithiobacillus thiooxidans* as an indicator of corrosion rather than pH values resulting from bacterial sulfuric acid generation that is partially buffered by different concrete types.

SRB are usually associated with metal corrosion rather than with the deterioration of concrete. These bacteria, however, are widespread in nature and active in locations made anaerobic by microbial digestion of organic material. Whilst thiobacilli are considered to be responsible for the degradation of concrete above ground, research indicates that nitrifying bacteria, which are responsible for the oxidation of ammonia via nitrous acid to nitric acid, play a major role in the degradation processes occurring below ground. The action of nitric acid on the calcareous binding material of concrete results in the production of calcium nitrate, a soluble salt, which is either lost from the concrete resulting in the formation of corrosion pits, or remains, thus adding a salt to the pore water.



ABOVE:
Fig. 5. (a) Biofilm of SRB (COURTESY CHRISTINE GAYLARDE). (b) A griffin colonized by algae and fungi (COURTESY G. MORTON).

RIGHT:
Fig. 6. Decaying concrete floor in a flooded cellar.
COURTESY K. MCCORMACK

FAR RIGHT (TOP):
Fig. 7. (a) Infected paint in a can. (b) Algal growth on the outside wall of a public house.
COURTESY JOHN GILLATT, THOR UK LTD

FAR RIGHT (BOTTOM):
Fig. 8. Mould growth in a suitcase.
COURTESY KENNETH SEAL

Organic acid corrosion of concrete

Mycelial development on a surface can be associated with the formation of mucilaginous sheaths. Sheath development in some genera of fungi is triggered by physical contact with the substratum. Obvious similarities exist between the proposed functions of the fungal mucilages and the extracellular polysaccharides of bacterial biofilms. Fungi isolated from the surfaces of monuments, the facades of buildings and from degrading concrete include many genera that are representative of air and soil flora. This points to the susceptibility of concrete to biodeterioration by heterotrophic micro-organisms. This author has isolated fungi from decaying concrete floors in flooded cellars (Fig. 6).

Emulsion paint

Only water-based-paints are susceptible to biodeterioration during their manufacture which may give rise to in-can problems. Thinning of the paint results when the thickener, usually a cellulose ether, is attacked by cellulase enzymes produced by bacteria and fungi introduced into the formulation via contaminated components. Talc, which is used as an extender in paint formulation, has been cited as a possible source of contamination. The detection of contaminants at the surface of emulsion paint (Fig. 7a), together with gas evolution (the production of 'off odours') have also been attributed to microbial contamination.

Films of oil- and water-based paints are colonized by micro-organisms on the outside (Fig. 7b) and inside of buildings. This aspect of biodeterioration can be both unsightly and hazardous to health.

The control of biodeterioration

Despite the availability of a wide selection of biocides for use against biodeteriogens, the number of formulations that is deemed acceptable is constantly reviewed because of their potentially hazardous effect on the environment. Furthermore, there is a large body of evidence and thus concern, that micro-organisms within biofilms (including certain pathogenic organisms) are less susceptible to the activity of biocides than their planktonic counterparts. Until we are able to control biodeterioration without the use of biocides, it is here to stay.

Ladies and gentlemen – I rest my case (Fig. 8)!

● *Glyn Morton is Professor of Environmental Microbiology and Director of Research in the Department of Forensic and Investigative Science, University of Central Lancashire, Preston PR1 2HE, UK. Tel. 01772 894373; email lhgmorton@uclan.ac.uk*

Further reading

Allsopp, D., Seal, K.J. & Gaylarde, C.C. (2003). *Introduction to Biodeterioration* 2nd edn. Cambridge: Cambridge University Press.

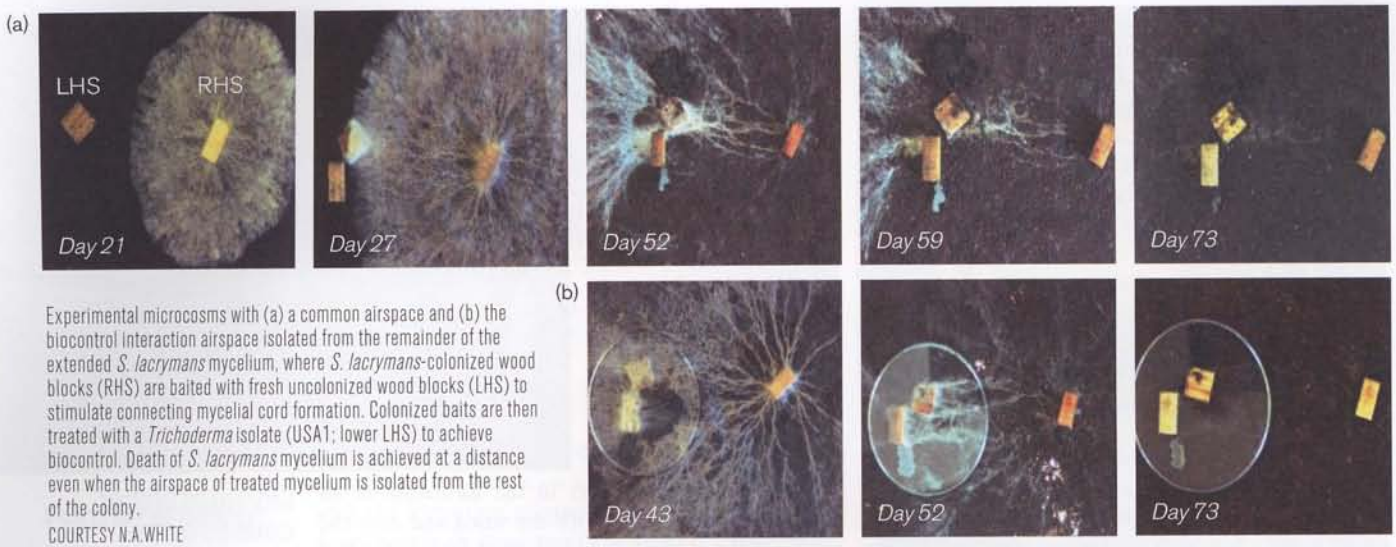
Bousher, A., Chandra, M. & Edyvean, R. (editors) (1995). *Biodeterioration and Biodegradation 9, Proceedings of the 9th International Biodeterioration and Biodegradation Symposium.* Institute of Chemical Engineers.

Gaylarde, C.C. & Morton, L.H.G. (2002). Biodeterioration of mineral materials. In *Encyclopedia of Environmental Microbiology*, pp. 516–527. Edited by G. Bitton. New York: Wiley.

Morton, L.H.G., Greenway, D.L.A., Gaylarde, C.C. & Surman, S.B. (1998). Consideration of some implications of the resistance of biofilms to biocides. *Int Biodet Biodegrad* 41, 247–260.

Morton, L.H.G. & Gaylarde, C.C. (2001). Slimes in biodeterioration. *Culture* 22, 1–4.

Seal, K.J. & Morton, L.H.G. (1986). Biodeterioration of chemical materials. In *Biotechnology*, Vol. 8, pp. 584–606. Edited by H. J. Rehm & G. Reed. Weinheim: VCH.



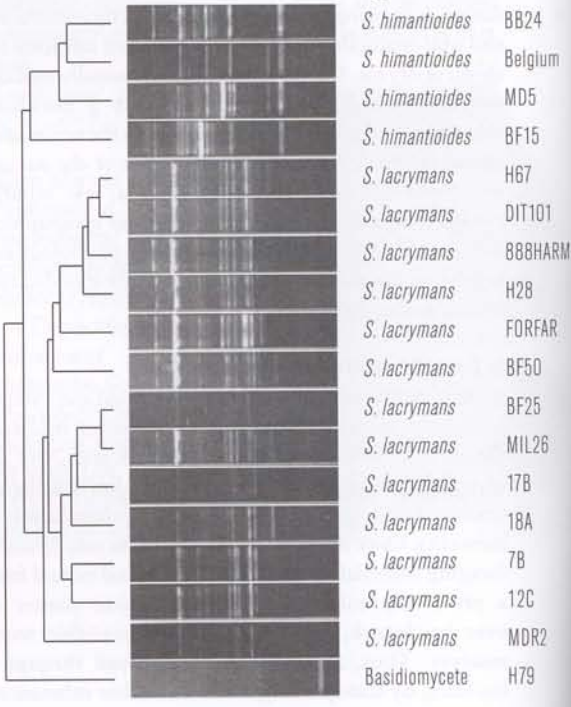
Experimental microcosms with (a) a common airspace and (b) the biocontrol interaction airspace isolated from the remainder of the extended *S. lacrymans* mycelium, where *S. lacrymans*-colonized wood blocks (RHS) are baited with fresh uncolonized wood blocks (LHS) to stimulate connecting mycelial cord formation. Colonized baits are then treated with a *Trichoderma* isolate (USA1; lower LHS) to achieve biocontrol. Death of *S. lacrymans* mycelium is achieved at a distance even when the airspace of treated mycelium is isolated from the rest of the colony.
COURTESY N.A.WHITE

Controlling the growth of *S. lacrymans*

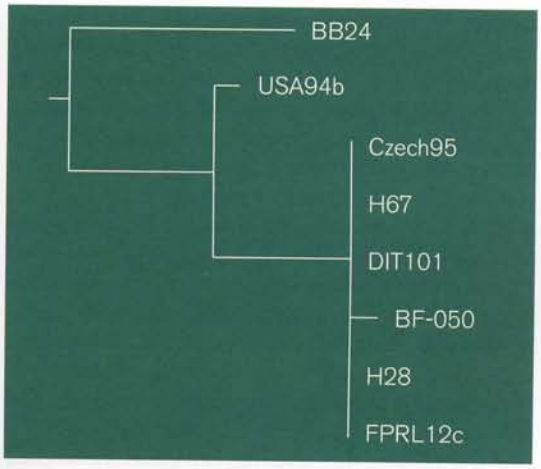
Experimentation with full-scale models of parts of buildings confirms observations from the woodland environment that the biomass of the dry-rot fungus is distributed between woody and non-woody resources. In the built environment, a key to controlling the dry-rot fungus is to break the connection between wood and sources of both moisture and the mineral components of masonry. In addition, the fungus can be disabled rapidly by ventilation, but quickly revives if stagnant air conditions reoccur. Controlling dry rot by such methods is now termed 'environmental control'. Such a strategy demands regular and careful building maintenance and inspection, the latter sometimes aided by the use of remote sensing moisture meters. Chemicals have traditionally been used when environmental control has not been considered or is deemed impracticable. An alternative, which has been occasionally used, depends upon the heat sensitivity of *S. lacrymans* and in some situations is feasible. Developed in Denmark, the procedure involves heating the whole of a tented building, or isolated parts of a building, to a temperature of 50 °C using moist heat. A final, as yet still experimental method of controlling dry rot involves the use of competitor fungi, notably isolates of *Trichoderma*. To date such biocontrol works well in microcosms, but is disappointing in the field. Reasons for this probably relate to issues such as inoculum potential, the undoubted fit between the needs of *S. lacrymans* and the environment which may be found in badly maintained or poorly designed buildings and the inappropriate source of the *Trichoderma* isolates used until recently. The enhanced performance of *Trichoderma* isolates from the natural woodland environment of *S. lacrymans* holds promise for the future. For example, new isolates from northern California in the USA have demonstrated an ability to produce volatiles that can kill extended *S. lacrymans* mycelial systems even without contact between the two organisms. This has not been reported before.

The origins of dry rot?

Despite its widespread occurrence in the built environment, *S. lacrymans* has rarely been found colonizing woodland environments. Fruit bodies have been found in northern India (Himalayan foothills), the Czech Republic and the USA (Mount Shasta, northern California), although the identity has been verified for only the first two using molecular methods (SDS-PAGE and RAPD and rDNA-ITS PCR). Investigation of the



RIGHT:
RAPD fingerprints of strains of building and Himalayan woodland (H67 and H28) *S. lacrymans* isolates and its close relative *S. himantioides*. Similarities between building and woodland isolates of *S. lacrymans* may support suggestions that strains currently affecting buildings are descended from those accidentally imported from woodlands such as those in the Himalayas several centuries ago.
COURTESY N.A. WHITE



LEFT:
Dendrogram based on a distance-based analysis of the ITS1, 5·8S and ITS2 sequences of *Serpula* species. The European 'building' and 'wild' (H67, H28 and Czech95) isolates were identical. Woodland isolate USA94b lies between all other *Serpula* isolates studied and *S. himantioides* (BB24) which may indicate that much of the evolutionary history of the species occurred in Northern America.
COURTESY N.A. WHITE

molecular variation and phylogeography of building and woodland *S. lacrymans* isolates and its closest relatives, informs a demographic database and may indicate how the current geographic distribution of the dry-rot fungus has developed. From studying the organism in the wild we may also develop ideas for better control of the organism in the built environment. However, there is no doubt that the internal environment of buildings should not be conducive to the growth of *S. lacrymans* and that good maintenance, careful design and appropriate usage will prevent damage by the dry-rot fungus. Indeed prevention of dry rot could be considered more of an educational issue than a technological or scientific one. However, in circumstances where lack of finance, past mistakes or lack of understanding have allowed problems to develop, we still need better science-based solutions.

● *Prof. J.W. Palfreyman is Head of the School of Contemporary Sciences, University of Abertay Dundee, UK, and was instrumental in setting up the Dry Rot Research Group at Abertay. With an interest in historic buildings much of his research on dry rot has centred around developing less destructive ways of treating the fungus and, perhaps more importantly, preventing its occurrence within the built environment.*
For further information see
http://scieng.tay.ac.uk/dry_rot/
email j.palfreyman@tay.ac.uk

● *Dr N.A. White is a lecturer in microbiology in the School of Contemporary Sciences, University of Abertay Dundee, UK, and a researcher within the Dry Rot Research Group and SIMBIOS. Her research activities centre on the physiology, ecology and phylogeography of S. lacrymans, and on modelling fungal growth and community dynamics.*
email n.a.white@abertay.ac.uk

Further reading

Palfreyman, J.W. & Low, G. (2002). *The Environmental Control of Dry Rot. Technical Advice Note for Historic Scotland. TAN 24*. Edinburgh: Historic Scotland.

Ridout, B. (2000). *Timber Decay in Buildings. The Conservation Approach to Treatment*. New York: E. & F.N. Spon.

White, N.A., Dehal, P.K., Duncan, J.M., Williams, N.A., Gartland, J.S., Palfreyman, J.W. & Cooke, D.E.L. (2001). Molecular analysis of intraspecific variation between building and 'wild' isolates of *Serpula lacrymans* and their relatedness to *S. himantioides*. *Mycol Res* 105, 447–452.

Education Colloquium

BioSciences Federation
(in collaboration with the LTSN Centre for Bioscience)

Education Colloquium

Changes and Challenges
The Changing Face of the Bioscience Undergraduate

1000–1700, Monday 6 October 2003

Hamilton House (NUT HQ), Mabledon Place, London WC1H 9BD

This one day event aims to consider the mismatch between what science students learn at school and what they are expected to know when they begin their university courses. It will bring together school teachers, careers advisers and admissions tutors, providing them with information about recent changes in the school science curriculum and discussing ways of meeting the resultant challenges.

Key issues include:

- How can we attract the best students into science?
- How is the school science curriculum going to change?
- How will it affect the quality of our future science undergraduates?

The meeting will be chaired by Reverend Professor Michael Reiss (Head of School, Institute of Education, University of London), who has been a driving force behind the new Salters' Nuffield Biology 'A' level.

There will be two talks:

- *Changes to school science* (Rebecca Edwards, QCA)
- *The mismatch between school science and university expectations* (Peter Cotgreave, SBS)

And three roundtables on:

- *New challenges faced by first year undergraduates*
- *Student perception of university science courses*
- *The link between universities and schools*

The colloquium will be followed by a drinks reception.

Lunch and refreshments will be provided.

Admission is free, but pre-registration is essential as places will be limited.

For further information and to register online see **www.bsf.ac.uk**

Closing date for registrations: **30 September 2003**.

Sponsored by: *The Biochemical Society, British Society for Immunology, Institute of Biology, The Physiological Society, Society for Experimental Biology, Society for General Microbiology.*

Lichens, agents of monumental destruction

Mark R. D. Seaward

Lichens are a familiar sight on buildings and trees. These symbiotic associations of fungi and algae or cyanobacteria are generally perceived to be harmless to the environment, but as Mark Seaward describes, they can attack stonework, resulting in damage to monuments, churches and other structures.

Modern microscopical and chemical techniques have confirmed that many lichen species contribute to the deterioration of a wide range of materials, particularly rocks and stonework, as a result of physical and/or chemical processes. In the past, attention was drawn to the possible effect of dissolved carbon dioxide, derived from lichen respiration, attacking the substratum to produce pits and channels for easier penetration of hyphae, with attendant loosening of mineral particles and their incorporation into lichen tissue. Such effects, although important on a geological timescale, have so far been considered to be minimal in terms of the life of stone buildings and monuments. Many lichen species create microclimatic effects at the thallus/substratum interface, particularly in terms of water retention, which undoubtedly lead to mechanical damage to stonework on a short timescale of 10 or so years. Various crustose and squamulose lichens are implicated, their aggressive behaviour no doubt promoted by particular man-made environmental conditions. Furthermore, forces generated by climatic wetting and drying of lichen thalli cause them to expand and contract in conjunction with the chemical breakdown of substrata by lichen acids.

Lichen acids have a relatively low solubility, but they are effective chelators, forming metal complexes with silicates, etc., derived from the substratum. X-ray powder diffraction and transmission electron microscopy have clearly demonstrated the presence of characteristic alteration products at the interface between rocks and various lichens. Experiments involving pure lichen acids or lichen fragments incubated with different types of rock have confirmed these observations.

Destructive role of oxalates

Oxalic acid secreted by the mycobiont is extremely soluble in water and acts as a chelator of metal ions, and oxalates formed at the thallus/substratum interface are closely related to the chemical composition of the rock; thus species growing on serpentinite, mainly composed of magnesium silicate, form magnesium oxalate dihydrate at the interface. Other alteration products have been shown to be incorporated into the thallus and/or precipitated at the lichen/substratum interface, such as manganese oxalate and copper oxalate on manganese-rich and copper-rich rocks, respectively. However, the commonest oxalate found in lichens is that of calcium, the thallial content ranging from 1 to 50 % according to the species and its underlying substratum. Calcium oxalate exists in two hydrated forms, monoclinic monohydrate (whewellite) and tetragonal dihydrate (weddellite). The monohydrate form is the major biodeterioration product and the ratio between this and the dihydrate form is dependent on various environmental factors. The production of calcium oxalate dihydrate by thalli, which is a measure of a lichen's capacity to biodeteriorate its substratum, is related to microclimatic conditions such as temperature and humidity of the air as well as the chemical and physical nature of the substratum. It would appear that lichens growing on humid sites produce calcium oxalate monohydrate, whereas those from drier sites produce a mixture of the monohydrate and dihydrate.

Many lichens known to contain calcium oxalate undoubtedly cause extensive corrosion substrata and they are capable of producing it on a wide variety of substrata: *Dirina massiliensis* forma *sorediata*, for example, has the capacity to produce encrustations of various thicknesses, with different concentrations of calcium oxalate and a variable chemistry, derived from the following substrata: gypsum/calcite underlying a fresco, stucco of a church wall, a Roman brick wall, a lead/glass interface of a church window, mortar and acidic stone; the effectiveness of this lichen to degrade its particular substratum being determined by various environmental conditions. The ability of lichens growing on non-calcareous substrata to produce significant levels of calcium oxalate is particularly interesting: FT-Raman spectroscopic studies of lichens on granitic monuments have shown that some species are capable of producing calcium oxalate, significant levels of calcium for its production being derived from the atmosphere or from leachates of neighbouring substrata.

The dramatic spread of *D. massiliensis* forma *sorediata* in Europe, more particularly England, in recent years

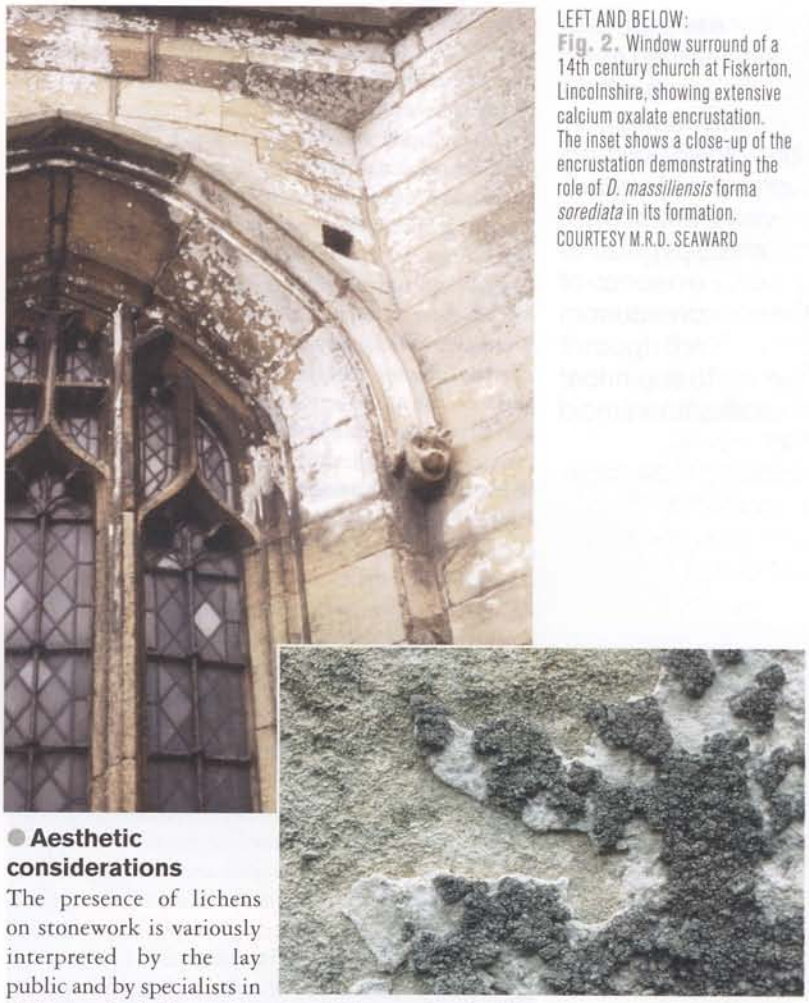
RIGHT:
Fig. 1. Renaissance frescoes attacked by the lichen *D. massiliensis* forma *sorediata*. Note that in the central area, paintwork incorporated into the lichen thalli has been removed by light brushing adopted in conservation work.
COURTESY M.R.D. SEAWARD

has been facilitated by new environmental regimes, including qualitative changes in air pollution, which have allowed it to dominate substrata in the wake of the rapid disappearance of other more pollution-sensitive species. It is by no means the only organism implicated in short-term deterioration processes: other lichens, and indeed other micro-organisms, capable of adapting to man-made disturbances can be equally destructive; recent changes have been conducive to increasingly detrimental invasion by certain aggressive lichens, such as nitrophilous species as a consequence of environmental hypertrophication. Such evidence could help to explain why it is that monuments, undamaged for many centuries, appear in recent years to be vulnerable to lichen attack, in addition to the known problems resulting from air pollution.

Frescoes and churches under attack

Palazzo Farnese, a 16th century mansion at Caprarola, Italy, features a circular courtyard surrounded by cloisters on ground and first floor levels, the inner walls of which bear contemporary frescoes. The water-based paintwork had biodeteriorated and examination revealed that a single lichen species, *D. massiliensis* forma *sorediata*, was responsible for the disfigurement (Fig. 1). This gave great cause for concern, the attack being very pronounced in many places, and clearly demonstrating the predilection of this lichen for the brown and yellow pigments, rather than the red pigment which contained one or more metals antagonistic to its growth. Using FT-Raman spectroscopy at Bradford University (under the direction of Professor H.G.M. Edwards), it was shown that this lichen produced calcium oxalate encrustations at the thallus/fresco interface up to 18 mm in thickness in less than 12 years. A 60 % obliteration of the fresco by this lichen, a frequent occurrence, generated more than 1 kg of calcium oxalate over a similar time period; furthermore, with the incorporation of calcite and gypsum into the thallus encrustation, it is likely that more than four times this amount of the underlying substratum has been chemically and physically disturbed.

The short-term biodeteriorative capacity of this lichen is not specific to the above-mentioned frescoes; detailed studies of it on exterior stonework of English churches, as demonstrated by a 14th century church at Fiskerton in Lincolnshire, have shown its similarly destructive nature. In the past, encrustations generated by this, and no doubt other lichen species, have been misinterpreted as the remaining traces of a whitish coating or rendering applied as a decorative or protective surface in a 19th or 20th century restoration programme (Fig. 2). It is now clear that this is not so, since these renderings consist essentially of calcium oxalate and remains of the thalli producing them. The encrustations are usually more than 0·5 mm in thickness and cover considerable areas of many church walls throughout England.



LEFT AND BELOW:
Fig. 2. Window surround of a 14th century church at Fiskerton, Lincolnshire, showing extensive calcium oxalate encrustation. The inset shows a close-up of the encrustation demonstrating the role of *D. massiliensis* forma *sorediata* in its formation.
COURTESY M.R.D. SEAWARD

Aesthetic considerations

The presence of lichens on stonework is variously interpreted by the lay public and by specialists in different disciplines, whose attitudes are inevitably coloured by differing aesthetic and practical considerations. The lichenologist regards the appearance of a lichen mosaic as a natural feature of ancient monuments, finding the diversity of species present aesthetically pleasing, besides being both taxonomically and ecologically interesting. There is a direct correlation between the composition of the flora and the passage of time, the different lichen communities established on buildings and monuments reflecting the various materials employed in their construction and often correlating to the chronology of successive building phases, therefore assisting in archaeological interpretation. Furthermore, since lichens are exceedingly sensitive to environmental change, the diversity of the flora can be a reliable indication of the level of air pollution which in itself is one of the most serious factors in the deterioration of ancient monuments. It is ironic that in a bland, homogenous urban environment, where a lichen mosaic would be a welcome relief to the eye, the higher levels of air pollution prevent its establishment, only allowing the existence of a monotonous flora

composed of a few algae and lichen crusts. It is pleasing to note that the undoubted improvement in air quality of many cities in recent years is reflected in the continued recovery of their lichen floras.

On the other hand, fine art specialists concerned with the conservation of ancient monuments view the encroachment of lichens from a very different standpoint: inscriptions and fine details may be obscured, and, depending on the nature of the substratum, and in some cases the ambient conditions, serious physical damage is often caused through lichen-induced biodeterioration. The lichen floras vary considerably according to the spatial differences in the chemical properties of stone surfaces, the micro-environmental conditions and the overall influence of air pollution.

Monument conservation

Clearly, it is necessary to determine which species are disfiguring but intrinsically harmless, and which cause actual physical damage. Baseline work is a prerequisite to research designed to establish the nature of the interface between problematic lichens and their substrata, and field trials intended to test the relative effectiveness of differing techniques and treatments for the removal and discouragement of lichens from stonework. Any treatment should be selected with care, since although immediately effective, the long-term effects are likely to be deleterious. Mechanical methods involving scraping and brushing, usually followed by washing, are tedious, damaging and often ineffective. Absorbed water may adversely affect the monument, particularly under fluctuating temperature regimes; although penetration can be minimized by the use of water repellents, entrapped water and rising damp can nevertheless prove highly destructive.

A wide range of biocides have been tried, many of which have since been rejected due to side effects such as crystallization of soluble salts that discolour stonework or that promote secondary biological growths more unsightly than those removed. Any decision to remove lichens from stonework must not be undertaken without careful consideration of the wider implications of long-term effects. Unfortunately, it has to be acknowledged that the problem is under-researched and much of the work published to date is of a largely empirical nature which has yet to be adequately substantiated by long-term experimentation. It remains for future generations to judge the relative effectiveness of the various conservation techniques currently employed.

● *Mark Seaward is Professor of Environmental Biology in the Department of Environmental Science, University of Bradford, Bradford BD7 1DP, UK.*
email m.r.d.seaward@bradford.ac.uk

Further reading

For background information on lichens, see the article by David Hill 'Lichens and co-ordination of the symbionts' which appeared in the August 2001 issue of *Microbiology Today*, pp. 124–127.

SGM Basic Practical Microbiology courses

September 2002 saw the start of the second year of *Basic Practical Microbiology* one-day courses for school science teachers and technicians. This year the SGM has been extremely fortunate in being able to run its courses out of the university laboratories of society members. It has certainly made it much easier to organize the workshops and the teachers and technicians have appreciated being able to use dedicated microbiology laboratories. It is hoped that this partnership approach will continue, giving universities the opportunity to showcase their facilities to advisers to potential future students.

Course leaders John Schollar and John Grainger have travelled far and wide to deliver courses at the University of Reading, University of Leeds, University of Hertfordshire, The Queen's University of Belfast and Exeter University. The courses have continued to be immensely popular and 133 teachers/technicians have been successfully trained.

The aims of the programme are to instill confidence and to support teachers and technicians in carrying out all aspects of practical microbiology safely and at the appropriate level within their laboratory. Feedback has shown that over 75 % of those who attended the course have found it extremely useful and 92 % are now confident to go back and teach/provide support for practical microbiology in their school or college.

This comment from a teacher in Belfast highlights the positive reaction of trainees. '*An excellent course from the first activity to the last. John and John were excellent in their delivery of information and practical hints. This is the best science/education-related course I have attended. I would be delighted to attend a follow up to this course!*'

The outlook for microbiology in schools is bright with around three quarters of delegates teaching the microbiology/biotechnology option at A level. It is hoped that this will have a knock-on affect and inspire more students to study microbiology at university. Certainly the volume of practical enquires received in the External Relations Office has risen sharply since the courses began, showing that more microbiology laboratory work is being carried out in schools.

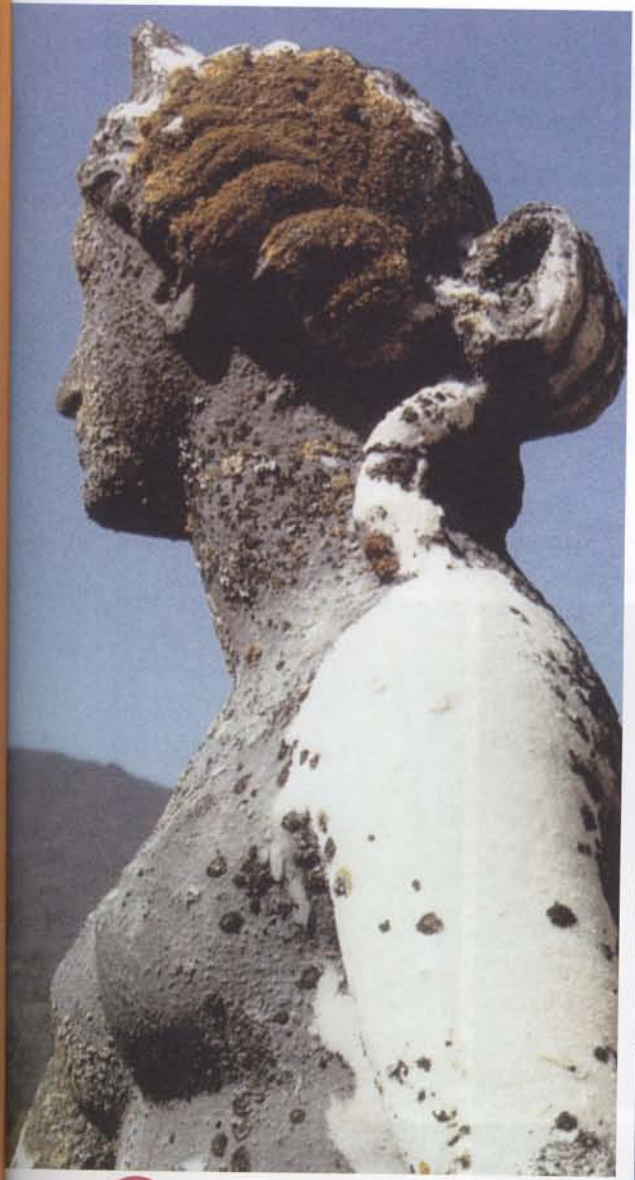
Arrangements are currently being made for the series of courses that will take place in 2003/2004. Full details will be posted on **www.microbiologyonline.org.uk** as soon as they are available. Further information about the course content can already been seen there.

● ***Dariel Burdass, Education Projects Administrator***

ABOVE: John Schollar demonstrates to teachers at an SGM Basic Practical Microbiology course. PHOTO D. BURDASS

Conservation of monumental stones by bacterial biomineralization

Brunella Perito & Giorgio Mastromei



Microbes are often responsible for the decay of stonework, but Brunello Perito and Giorgio Mastromei have found a way of using bacteria to conserve monuments through the technique of biomineralization.

Monumental stone decay is a consequence of the weathering action of physical, chemical and biological factors, which induce a progressive dissolution of the mineral matrix (Fig. 1). Attempts to slow down monument deterioration have used conservation treatments with inorganic or organic products, but their use presents several drawbacks. A new approach to conservation treatment of calcareous stones exploits bacterial biomineralization.

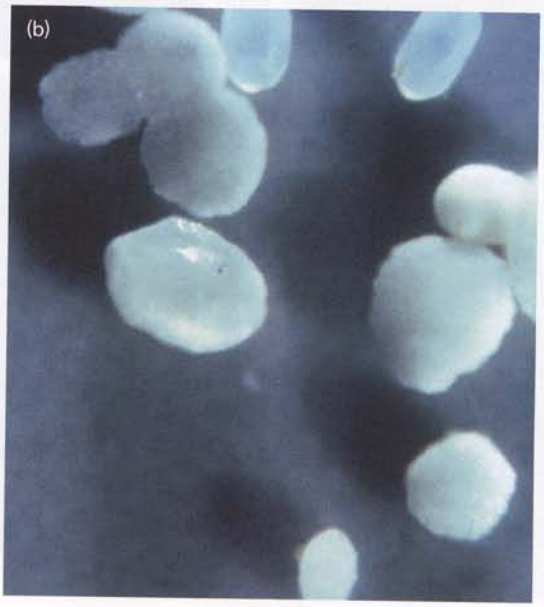
Calcium carbonate ($CaCO_3$) precipitation is a major biogeochemical process very common to microbes living in different environments. Several studies have pointed out the complexity of the phenomenon, which is influenced by the environmental physico-chemical conditions, and is correlated both with metabolic activity and cell-surface structures.

Application of living cultures of selected calcinogenic bacteria on limestone has been shown to induce calcite precipitation inside stone porosity, but it might generate other problems. In fact, chemical reactions due to metabolic by-products and growth of fungi, resulting from the application of organic nutrients for bacterial development, may have negative effects on the stone itself. For this reason, development of a stone treatment without viable cells seems a better biotechnological tool. To achieve this, it is necessary to understand the molecular mechanisms by which bacteria foster $CaCO_3$ precipitation, since this phenomenon is poorly understood both at molecular and genetic levels.

Work with *Bacillus subtilis*

In our laboratory we are studying calcite crystal formation in *Bacillus subtilis* in order to identify bacterial genes and cell structures involved in the biomineralization process. This work is part of the 'Bioreinforce' EC project (http://www.ub.es/rpat/bioreinforce/bioreinforce.htm) directed to develop a biomediation calcite precipitation method for conservation treatment of monumental stones.

B. subtilis produces calcite crystals when grown on an appropriate medium (Fig. 2). We isolated several *B. subtilis* mutants impaired in calcite crystal



TOP LEFT:
Fig. 1. Marble Statue (1700), on the balustrade of the Villa Dosi-Dolfini, Pontremoli, Italy. The presence of old biological patina and new lichen encrustation can be seen.
COURTESY B. PERITO & G. MASTROMEI

LEFT:
Fig. 2. Calcite crystal production by *B. subtilis*. (a) Crystal formation on the surface of *B. subtilis* cells. (b) Crystals produced by *B. subtilis* observed by optical microscopy.
COURTESY B. PERITO & G. MASTROMEI

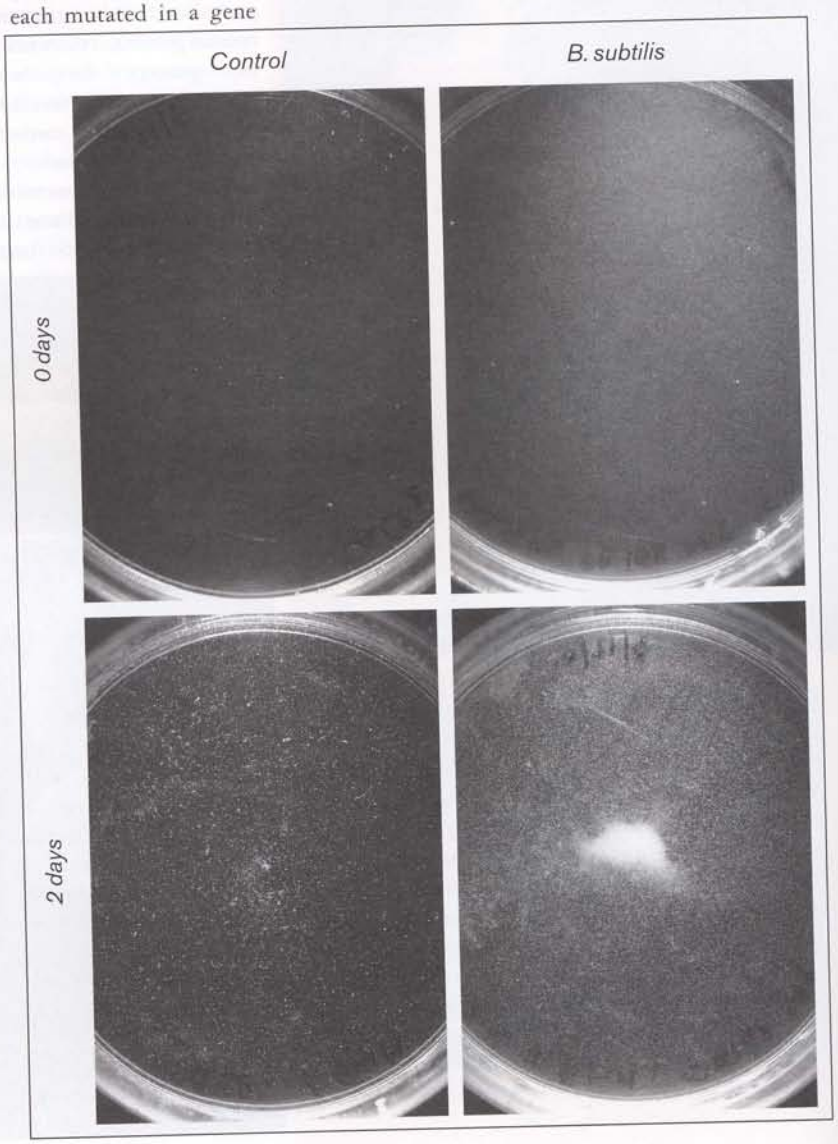
RIGHT:
Fig. 3. Map of the *B. subtilis* chromosome region containing the *ysiB* and *ysiA* genes. Arrows show the direction of transcription. Putative functions: *lcfA*, long-chain acyl-CoA synthetase; *ysiA*, transcriptional regulator (TetR/AcrR family); *ysiB*, 3-hydroxybutyryl-CoA dehydratase; *etfB*, electron transfer flavoprotein (β subunit); *etfA*, electron transfer flavoprotein (α subunit).
COURTESY B. PERITO & G. MASTROMEI

LOWER RIGHT:
Fig. 4. Calcite precipitates obtained with autoclaved cells of *B. subtilis*. Control: $CaCl_2$ solution.
COURTESY B. PERITO & G. MASTROMEI

production. Sequence analysis of their mutated genes revealed that in many cases the putative functions were linked to fatty acid metabolism. Two of these genes, *ysiA* and *ysiB*, belong to a putative transcriptional cluster of five genes (Fig. 3). We focused our attention on this cluster and produced, by insertional mutagenesis, *B. subtilis* isogenic strains each mutated in a gene of the cluster. Mutants were tested for their ability to produce calcite and all, except one, impaired crystal formation. We are working on the hypothesis that this cluster could control the synthesis of an intermediate of fatty acid metabolism, directly or indirectly involved in promoting $CaCO_3$ precipitation.

The other experimental approach was based on searching for the *B. subtilis* cell structures specifically involved in $CaCO_3$ precipitation. We used an *in vitro* precipitation test, where the samples, suspended in a $CaCl_2$ solution, were exposed to ammonium carbonate vapours. In this experiment, killed cells of *B. subtilis* induced calcite precipitation (Fig. 4). We are now testing different *B. subtilis* cell fractions to identify the structure(s) important for this process. The next step in the Bioreinforce project will be to use these fractions to treat monumental stones.

● *Brunella Perito and Giorgio Mastromei are based in the Department of Animal Biology and Genetics 'Leo Pardi', University of Florence, via Romana 17, 50125 Florence, Italy.*



Further reading

Barabesi, C., Salvianti, F., Mastromei, G. & Perito, B. (2003). Microbial calcium carbonate precipitation for reinforcement of monumental stones. In *Molecular Biology and Cultural Heritage*, pp. 209–212. Edited by C. Saiz-Jimenez. The Netherlands: A.A. Balkema.

Castanier, S., Le Métayer-Levrel, G., Orial, G., Loubière, J.F. & Perthuisot, J.P. (2000). Bacterial carbonatogenesis and applications to preservation and restoration of historic property. In *Of Microbes and Art: The Role of Microbial Communities in the Degradation and Protection of Cultural Heritage*, pp. 203–218. Edited by O. Ciferri, P. Tiano & G. Mastromei. New York: Plenum.

Fortin, D., Ferris, F.G. & Beveridge, T.J. (1997). Surface-mediated mineral development by bacteria. *Rev Mineral* 35, 161–180.

Tiano, P., Biagiotti, L. & Mastromei, G. (1999). Bacterial biomediated calcite precipitation for monumental stones conservation: methods of evaluation. *J Microbiol Methods* 36, 139–145.

Sulfate-reducing bacteria in biofilms on metallic materials and corrosion

Iwona B. Beech

Microbial growth can cause serious corrosion of metals. Iwona Beech explains the role of sulfate-reducing bacteria in this phenomenon.

Corrosion is a naturally occurring process by which materials fabricated of pure metals and/or their mixtures (alloys) undergo chemical oxidation from ground state to an ionized species. It is an electrochemical process involving the transfer of electrons in the presence of an electrolyte through a series of oxidation (anodic) reactions and reduction (cathodic) reactions. After a certain time, the oxidation products (corrosion products) adhere to the surface and form one or more layers that serve as a diffusion barrier to reactants. Such layer(s), depending on their chemistry and morphology, may act as a protective barrier against further metal deterioration. Changes in the environmental conditions can affect the stability of the protective layers and, therefore, the overall susceptibility of the material to corrosion.

Biofilms on metallic materials

In natural habitats and man-made systems, surface-associated microbial growth, i.e. biofilms, influence the physico-chemical interactions between metal and environment, frequently leading to deterioration of the metal (Fig. 1). Biofilms consist of microbial cells, their extracellular polymeric substances (EPS) and adsorbed organics. In addition, inorganic precipitates may originate from the bulk aqueous phase or be present as corrosion products (Fig. 2). Physiologically diverse micro-organisms and their metabolic products, e.g. enzymes, exopolysaccharides, organic and inorganic acids, and volatile compounds, such as ammonia or hydrogen sulfide, can alter electrochemical processes at the biofilm–metal interface through co-operative effects. For example, in a marine environment the presence of a biofilm can accelerate corrosion rates of carbon steel by several orders of magnitude. In contrast, certain types of biofilms produce a barrier effect, resulting in a substantial decrease in the corrosion rate of the metal.

Biocorrosion

Deterioration of metal under a biological influence is termed biocorrosion or microbiologically influenced corrosion (MIC) and a number of mechanisms have been identified, reflecting the variety of physiological activities carried out by different types of micro-organisms. These include the following:

- Accumulation of microbial metabolic products aggressive to the protective layers and to metal itself.
- Harbouring enzymes, which are able to effect reduction reactions at cathodic sites.
- Providing matrix for binding/sorption of diverse metal cations.

Demonstrating the presence of micro-organisms on a corroded metal surface, even if they are species known to produce aggressive metabolic by-products, is not sufficient evidence for their contribution to the deterioration process.

Sulfate-reducing bacteria

Sulfate-reducing bacteria (SRB) are the main group of taxonomically diverse micro-organisms which are classified as strictly anaerobic and which are distributed within two domains: *Archaea* and *Bacteria*. SRB perform dissimilatory reduction of sulfur compounds such as sulfate, sulfite, thiosulfate and sulfur itself to sulfide. Some species from the *Desulfovibrio* genus can grow with nitrate or fumarate as alternative electron acceptors. Compounds frequently used as a carbon source and electron donors and oxidized to acetate and CO_2 are lactate, pyruvate, malate, high molecular weight fatty acids or simple aromatic compounds, such as benzene or phenol. SRB can also degrade saturated hydrocarbons.

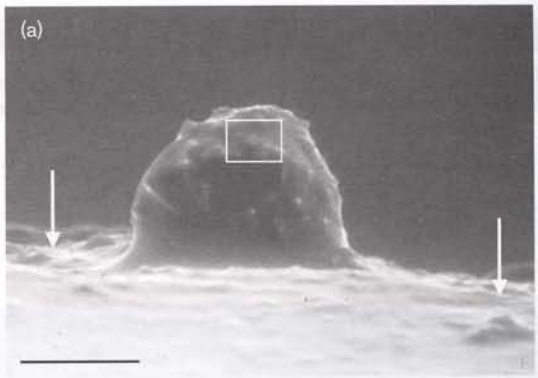
SRB are commonly isolated from biofilms formed in oxygen-free and aerated environments. Within the biofilm matrix SRB thrive within anoxic niches. During their growth SRB produce a large amount of hydrogen sulfide that assures the maintenance of anaerobiosis. SRB biofilms are readily formed on steel surfaces (Fig. 3). Some genera tolerate oxygen and even grow in its presence, indicating the existence of defence mechanisms against oxygen radicals. Catalase and superoxide dismutase are constitutively expressed during anaerobic growth of *Desulfovibrio gigas*. Studies into oxygen tolerance by SRB are progressing rapidly thanks to genomic sequencing of *Desulfovibrio vulgaris* Hildenborough and the detailed functional analysis of all oxygen-induced genes.

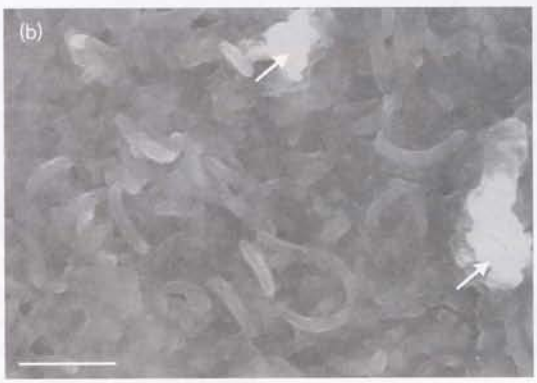
SRB-influenced deterioration of metallic materials – a historic perspective

Since 1934 SRB have been implicated in pitting corrosion of ferrous metals and their alloys in aquatic and terrestrial habitats, varying in nutrient content, temperature, pressure and pH values, under anoxic and oxygenated conditions (Fig. 4).

The activity of hydrogenase enzymes and/or the presence of iron sulfide

BELOW:
Fig. 1. Examples of severe biocorrosion of (a) iron pipes in a potable water distribution system inside an abandoned building and of (b) carbon steel piling in a marine environment in the presence of biofilms harbouring SRB.
COURTESY I.B. BEECH





RIGHT:
Fig. 2. Environmental scanning electron microscopy images of (a) fully hydrated biofilm formed on the surface of stainless steel tubing in a potable water distribution system under high flow conditions and (b) partially dehydrated biofilm from an area indicated by the rectangle in (a), revealing the presence of bacterial cells embedded in extracellular matrix. Please note the conditioning layer on the steel surface in (a) and corrosion products visible in (b), as indicated by the arrows. Bars, 5 µm.

FAR RIGHT:
Fig. 3. Atomic Force Microscopy (AFM) images of a 3-week-old biofilm formed on the surface of stainless steel by mixed species of SRB of the genus *Desulfovibrio*, revealing the presence of cells and exocellular material. The inset represents a single SRB cell. Bars, 1 mm (main image); 0·1 mm (inset).

OPPOSITE PAGE CENTRE:
Fig. 4. Scanning electron microscopy images of surfaces of (a) carbon steel and (b) stainless steel after the removal of 3-week-old biofilms formed in a marine and in a freshwater environment, respectively. Mixed populations of SRB were isolated from both types of biofilms. Please note the severe pitting attack visible on the surfaces.

OPPOSITE PAGE BOTTOM:
Fig. 5. AFM (a) topography and (b) deflection image of a single cell of an SRB of the genus *Desulfovibrio* in a 3-week-old biofilm developed on the surface of stainless steel. Corrosive FeS particles (black arrows) are distributed on the steel surface and also closely associated with the bacterial cell. The presence of bacteria and products formed as a result of their metabolic activities, e.g. FeS, can lead to a severe pitting attack on both carbon and stainless steel in marine and fresh water environments (as seen in Fig. 4), leading to severe failures (as depicted in Fig. 1). The size of each image is 1-5 µm.

ALL COURTESY I.B. BEECH

species were regarded as key mechanisms of SRB-influenced deterioration of steel. The cathodic depolarization theory proposed the mechanism of anaerobic corrosion of ferrous metal. The essential step in this theory involved the removal of hydrogen (cathodic depolarization) by SRB hydrogenase.

Hydrogenase, which catalyses the reversible oxidation of hydrogen according to the reaction $H_2 \rightarrow 2H^+ + 2e^-$, is present in all SRB. Hydrogenase activity is not dependent on viable cells. The lack of SRB detection based on viable counts or production of H_2S does not, therefore, necessarily indicate that enzymatic activity has ceased. Within a biofilm matrix, the enzyme can retain its depolarizing capabilities for months. Furthermore, a direct electron transfer between the adsorbed hydrogenase enzyme and steel surface can take place.

In the presence of SRB the main corrosion products formed on the iron surface are ferrous sulfides, which can be protective of or aggressive to the underlying metal (Fig. 5). It was proposed that corrosion proceeded under reduced conditions through (a) depolarization of cathodic areas by absorption of the polarizing H_2 into the crystal lattice of the FeS species or (b) the establishment of a galvanic cell, FeS/Fe, whereby the Fe becomes anodic and FeS cathodic. The corrosion caused by the biogenic FeS appears identical to that caused by inorganically produced FeS. However, the FeS activity diminishes with time, possibly as a result of the bonding of atomic hydrogen within the FeS crystal lattice. The removal of hydrogen by bacterial hydrogenase restores the FeS activity. SRB continually regenerate or depolarize FeS by removal of atomic hydrogen, thus maintaining high rates of corrosion.

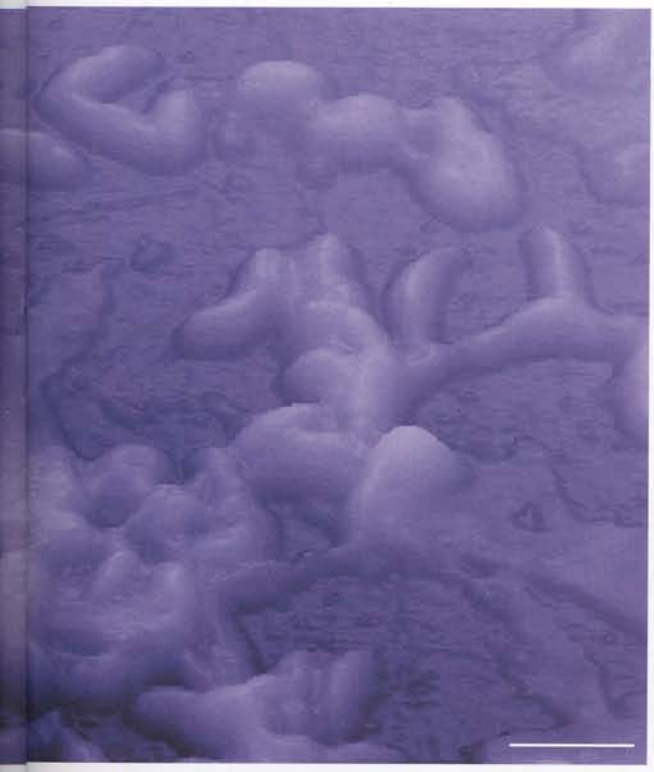
Current state of understanding of SRB-influenced corrosion

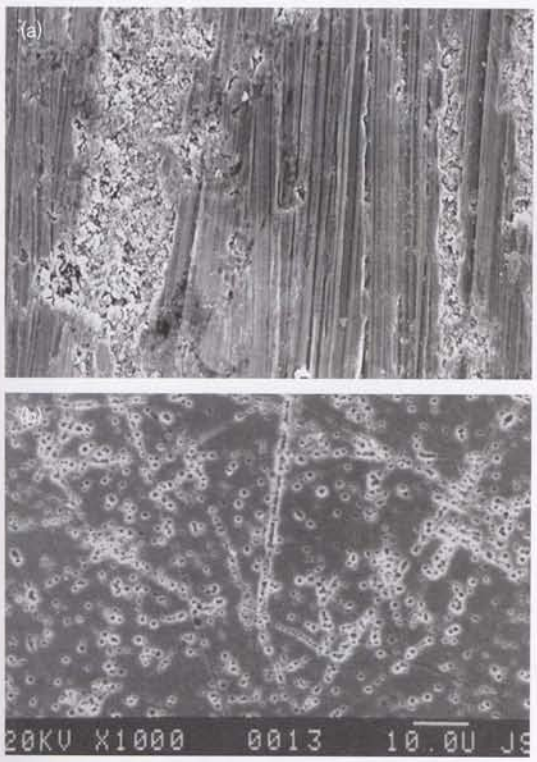
Corrosion under SRB influence is primarily realized as a localized attack, which occurs as a result of the activity of physiologically diverse SRB species present within biofilms on the metal substratum. These activities promote the establishment of localized chemical gradients leading to the formation of electrochemical cells and causing the loss of metal from locations on the surface.

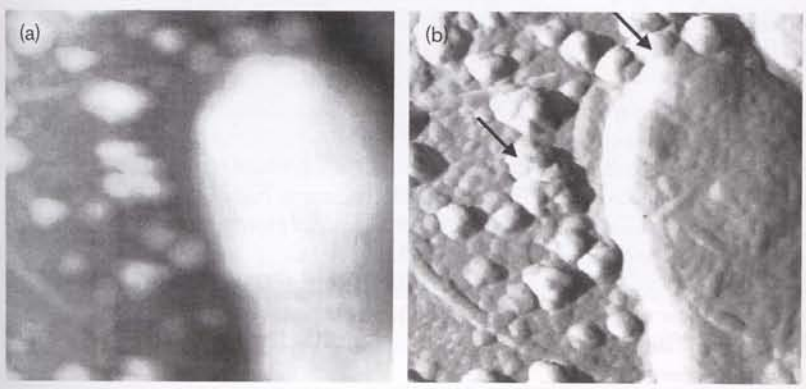
It is now generally accepted that the number of SRB detected in a system does not correlate with the extent of corrosion. Rather, the metabolic status of SRB is believed to be of importance. It is also becoming clear that one predominant mechanism of biocorrosion does not exist. According to a recent hypothesis, SRB-mediated corrosion of iron and its alloys occurs by a process of electron transfer from the base metal to oxygen as ultimate electron acceptor, through a series of coupled redox reactions of an electrochemical, biotic and abiotic character. The study of the importance of enzymatically catalysed reactions, not favoured under abiotic conditions, would aid our understanding of the role SRB play in corrosion.

Although it is recognized that sulfate-reducers vary in their ability to influence deterioration of metallic materials, to date no clear consensus has been reached in elucidating the importance of species specificity in corrosion processes. This specificity can possibly explain why, despite identical environmental conditions, biofilms composed of different SRB belonging to the same genus differ in their ability to deteriorate metals. Current progress in microbial genomics is likely to facilitate comparative analysis of SRB genomes, thus aiding the characterization of corroding and non-corroding, SRB-harbouring biofilms. Undoubtedly, better knowledge of the ecology of SRB communities and, therefore, their metabolic output can be of great importance when investigating the effect of biofilms on the corrosion behaviour of metallic materials and designing appropriate protection and prevention measures.

● *Dr. Iwona B. Beech is Reader in Microbiology in the School of Pharmacy and Biomedical Sciences at the University of Portsmouth, Portsmouth PO1 2DT, UK.*
Tel. 02392 842147; Fax 02392842142
email iwona.beech@port.ac.uk







Further reading

Beech, I.B. (2002). Biocorrosion: role of sulphate-reducing bacteria. In *Encyclopaedia of Environmental Microbiology*, pp. 465–475. Edited by G. Bitton. Chichester: Wiley.

Beech, I.B. & Coutinho, C.L.M. (2003). Biofilms on corroding materials. In *Biofilms in Medicine, Industry and Environmental Biotechnology – Characteristics, Analysis and Control*, Chapter 8, pp. 115–131. Edited by P. Lens, A.P. Moran, T. Mahony, P. Stoodley & V. O'Flaherty. London: IWA Publishing.

Geesey, G.G, Beech, I.B., Bremmer, P.J, Webster, B.J. & Wells, D. (2000). Biocorrosion. In *Biofilms II: Process Analysis and Aplications*, pp. 281–326. Edited by J. Bryers. Chichester: Wiley.

Hamilton, W.A. (2003). Microbially influenced corrosion as a model system for the study of metal microbe interactions: a unifying electron transfer hypothesis. *Biofouling* 19, 65–76.

Micro Shorts

ROYAL SOCIETY

Measuring Biodiversity

Following the consultation in 2002, to which SGM contributed, The Royal Society has produced a summary report *Measuring Biodiversity for Conservation.* One of the key outcomes from the World Summit on Sustainable Development in 2002 was the commitment to '*achieve by 2010 a significant reduction in the current loss of biological diversity*'. However, no sound basis currently exists for assessing global performance against this target. The Royal Society report recommends a global plan that will enhance what is currently known about biodiversity and will lead to the development of measures that can effectively assess the success of mitigating action. The report is available on the web at **www.royalsoc.ac.uk**; it does not mention micro-organisms specifically, but the full report due out in June will presumably do so.

Leeuwenhoek Lecture

Professor Brian Spratt FRS will deliver a lecture on *Bacterial populations and bacterial disease* at 1700 on Monday 17 November 2003, at St Mary's Hospital, London.

AWARDS

EMBO Award for Communication in the Life Sciences 2003

Applications are invited for this award which is intended for a life scientist who, while remaining active in research, has succeeded in making an outstanding contribution to the communication of science to the public. The award consists of a silver and gold medal, and 5,000 Euros. The range of eligible activities is broad and includes communication through the media, books, public outreach projects, or special initiatives (for example schools projects). Emphasis will be placed on originality and imagination. The award aims to reward the work of non-professional communicators, and encourage younger life scientists. Details and an application form are at **www.embo.org/projects/scisoc/com_medal.html** The closing date for applications is **31 August 2003**.

In Your Dreams

Scientists at the top of their sector, but looking for the time to fulfil a new idea or project away from the demands of their professional life are invited to apply for a new Dream Time award from NESTA (the National Endowment for Science, Technology and the Arts). Up to £40,000 is available to exceptional individuals to innovate and explore new ideas and associations that may emerge through periods of intense personal development over the course of up to one year. Dream Time Fellows can use this funding on a full- or part-time basis, working in tandem with their professional careers or in a period of time away from their employment before returning to work and putting what they have discovered to good use within their sector. Application is via NESTA's website (**www.nesta.org.uk/dreamtime**) where the full criteria of the awards are available. The closing date is **10 October 2003**.

The Biodeterioration Centre, University of Hertfordshire

Richard Smith

Biodeterioration can mean business. Richard Smith describes the unit set up at the University of Hertfordshire to monitor and investigate biodegradation problems.

The Biodeterioration Centre was borne 25 years ago out of local industry's need for an independent microbiological testing facility, and the entrepreneurial motivation of its founder, and my late father, Dr Neil Smith. In the early days in the late 1970s the Centre's work began as microbiological analysis of fuel samples from the Ministry of Defence at Portsmouth and British Aerospace at Hatfield, and occasional water microbiology tests for local industry. However, the bulk of the work was research into the biodeterioration of materials, which has continued as relentlessly as the cycling of the elements that it studies.

Many research studies have been performed over the years at Hatfield. Examples of these include the microbial degradation of Polaroid sunglasses by psychrophilic fungi; false teeth degradation by artificially cultured plaque populations; microbial corrosion of military hardware; the breakdown of emulsions of bitumen; and microbial fuel spoilage within nuclear submarines. The work has always been informative and rewarding, and often innovative and swashbuckling, as Neil Smith would dart around the laboratory planning the next 'conclusive' experiment long before completion of the previous one.

It was at about the same time as the Biodeterioration Centre started out within the Hatfield Polytechnic, that Legionnaires' disease made a dramatic entrance to the world of public health in Philadelphia, USA. Widespread concerns about this industrial disease led to cumbersome and complicated *Legionella* isolation and enumeration tests being offered as a service from the Centre. The client base expanded as water treatment engineers and building maintenance companies came from far and wide to use the services of the Centre.

The Laboratory now still offers *Legionella* testing as one of its core microbiological tests, although the method has been streamlined, with the benefit of greater efficiency and reduced costs. The Centre holds UKAS accreditation for *Legionella* testing, and many other standard microbiology tests, as well as retaining its fuel testing services for companies based in airports at Luton, Stansted, Manchester, and as far away as Liege and Rome. Domestic water potability tests make up a large part of today's work at the Centre, including long-established microbiological water testing contracts for the local pharmaceutical industries.

An air quality monitoring service has also evolved over the last decade. This has provided a wealth of experience of indoor air quality testing and investigations into 'sick building syndrome' from Moscow to Madrid. Recently the Centre has also been involved in external airborne microbiology monitoring at domestic composting facilities around the south-east.

Generating valuable commercial support to the progressive University of Hertfordshire, the Biodeterioration Centre has continually evolved to provide services where there is a requirement. This diversity demonstrates our strengths, but the secret of maintaining a loyal customer base is a commitment to a high quality service at all times, in all tasks. In addition, the Biodeterioration Centre continues to play an important role in the education and industrial experience of today's undergraduates and tomorrow's microbiologists within the university. As Director of the Centre, I look forward to the next 25 years of the irresistible science that is known as biodeterioration, and as sure as eggs is eggs, they will probably go off and we will be there to investigate why.

A typical project – fungal etching of sunglass lenses

A study of the etching of glass lens surfaces by the action of xerophilic fungi was carried out during the 1980s. Studies were done using commercial sunglasses treated with various carbon and energy sources, including artificial sweat, glucose, yeast extract and paper extract. The samples were held at a range of water activities (60–90 % relative humidity), for up to 180 days at tropical temperatures.

Etching of the glass surface was observed using the naked eye, and using optical microscopy. A rating system of etching was devised to classify the degree of biodeterioration.

Earlier research had implicated fungi of the genus *Aspergillus*, and had suggested that tropical conditions, along with a readily available nutrient source, would provide environmental conditions favourable for the surface growth of *Aspergillus*. The deteriogen had been observed to traverse the surface of the lenses. The concentrated organic acids in the water phase (hyphosphere) around the fungal hyphae were suspected of being corrosive to the glass. Deterioration of the lenses would be expected to result, providing spoilage of the product.

Indeed, experiments found that some types of sunglasses were clearly seen to be etched in this way, although the results were found to be manufacturer-dependent. For a while the Laboratory was known to hoard more unfashionable sunglasses than a Turkish tourist market! The undamaged samples were therefore generously distributed among the students of Biosciences, who were not generally known for their strict dedication to style at the time!

Richard Smith is Technical Manager, Biodeterioration Centre, Faculty of Natural Sciences, University of Hertfordshire, Hatfield, AL10 9AB, UK.
Tel. 01707 284545; Fax 01707 285046
email r.smith@herts.ac.uk

The International Biodeterioration & Biodegradation Society (www.biodeterioration.org)

The IBBS is a multidisciplinary organization concerned with the biodeterioration of commercially important materials. It aims to promote the science and technology of not only biodeterioration but also biodegradation and bioremediation. It holds scientific meetings and has an official journal, *International Biodeterioration and Biodegradation*, which is included in the annual membership subscription. Membership is open to anyone with a scientific, technical, practical or commercial interest in these fields.

For further information contact Mr John Gillatt, Thor Specialties, Wincham Avenue, Wincham, Northwich, Cheshire CW9 6GB, UK.

Pilzkrieg: the German wartime quest for penicillin

Gilbert Shama

Despite all their intelligence and scientific efforts, the Germans did not succeed in producing bulk supplies of penicillin during World War II. Gilbert Shama explains why.

The ultimate triumph of Anglo-American efforts to mass produce penicillin during the Second World War can be said to have eclipsed the existence of similar attempts in other countries. However, about a decade ago German historians began publishing accounts of their country's attempts to produce penicillin. The fact that their story is not more widely known about is largely due to the fact that these accounts were written in German. Yet, paradoxically, the first publications to document German activity in this area were compiled by Allied intelligence agencies. These reports were prepared under the auspices of the British Intelligence Objectives Subcommittee (BIOS) and the Combined Intelligence Objectives Subcommittee (CIOS) by teams of civilian and military scientists. They were originally given security classifications, but those reports dealing with purely industrial or commercial information were rapidly declassified and were published by the HMSO from 1946 until well into the 1950s.

The shadow of Germany

Towards the end of 1939 Howard Florey and Ernst Chain at the Sir William Dunn School of Pathology at Oxford secured a grant to study natural antibacterial agents. They chanced to start with penicillin and by the summer of 1940 had succeeded in isolating it and in showing that it possessed powerful antibacterial action *in vivo*. They published their preliminary findings in *The Lancet*. Also in that summer, Florey and a few trusted colleagues succumbed to a fear of imminent German invasion that was sweeping the nation and transferred spores of *Penicillium notatum* for safekeeping onto the linings of their jackets.

A threat of a more concrete kind reached Florey in April 1941. German scientists, he learned, were keen to examine penicillin and would attempt to acquire some through the Swiss pharmaceutical company Ciba Geigy. Florey wrote to Alexander Fleming as well as R. St John Brook, the head of the National Collection of Type Cultures, warning of the consequences of *P. notatum* falling into German hands. He also wrote of his concerns to Sir Edward Mellanby, Chairman of the Medical Research Council, who assured him that he was '*miles ahead*' of any competition and that there was no point in suppressing publication on penicillin in the national interest because effective antibacterials – the sulfonamides – were so widely available. Florey took the hint and in August 1941 a second paper, this time containing a wealth of technical information, appeared in *The Lancet*. Included were details of the culture medium for *P. notatum*, a method of assaying penicillin and illustrations of the, now celebrated, spouted ceramic culture vessels as well as harvesting procedures. Most importantly, the article revealed how to extract penicillin from crude fermentation broths. It was this crucial step that had defeated not only Fleming, but later also Harold Raistrick at the London School of Hygiene and Tropical Medicine and Roger Reid in the USA. In short, the paper provided all the information required to set up a penicillin manufacturing process – assuming, that is, that one possessed Fleming's strain of *P. notatum*.

Research and development of penicillin

Both of *The Lancet* papers reached Germany, via neutral Sweden. The pecking order for distribution ensured early access by Theodore Morell, Hitler's personal physician, described after the war by Albert Speer as '*interested only in money*'. The articles probably reached bona fide scientists in late 1942 which is when research proper began in Germany. Companies of all sizes, as well as universities and research institutes, became involved in a scramble to produce the antibiotic, especially most of the constituent companies of IG Farbenindustrie – Hoechst, Elberfeld, Marburg, and also E. Merck of Darmstadt, Schering AG of Berlin, Schott and Genossen of Jena and Knöll of Ludwigshafen.

The first stumbling block facing these would-be producers was obtaining a penicillin-producing strain of *Penicillium*. Although Fleming had assured Florey that he did not remember sending samples of his strain to Germany, his memory was at fault. A certain Dr Schmidt at the IG Marburg works had received a culture from Fleming some years before the war. Schmidt had never attempted to do anything with it, but with a revival of interest in penicillin, he tried to grow the strain. He failed and, perhaps doubting his mycological technique, he then sent the culture to Schering in Berlin, but they too were unsuccessful. The Germans made at least two further attempts to acquire this strain. The first was in Paris at the Pasteur Institute, whilst the second was at the University of Copenhagen. The Pasteur Institute did in fact possess a culture; Fleming had given it to Andre Lwoff. Although apparently no one in Denmark had Fleming's culture, Professor K. A. Jensen had read about penicillin from publications smuggled to him from Sweden and had succeeded in isolating a number of penicillin producers. In both cases the German envoys were duped and left empty-handed. However, with the fall of Holland, Germany had what Florey described in a letter as '*the best (mould) culture collection in the world*'. This was the Centraal Bureau voor Schimmelcultures (CBS) located at Baarn, near Utrecht. German microbiologists were not slow to arrive at this realization. Fleming had never deposited his culture with the CBS, but their culture catalogue showed that they held a closely related strain, *P. notatum* (Westling). The archives at Baarn contain scores of requests from German companies and universities. The strain had been deposited at Baarn many years before and would have been sub-cultured many times without regard to its antibiotic productivity – indeed in total ignorance that it even possessed such a trait. It was at best only

LEFT:
Sir Howard Walter Florey (1898–1968).
PHOTO SGM

a poor penicillin producer and there is no evidence that it ever featured prominently in German penicillin research. Interestingly, a paper published in *Nature* in November 1942 characterized the strain as a producer of notatin.

It was not long before German microbiologists set about isolating their own strains. Notable was Andreas Lembke, Director of a research institute in Kiel that was concerned primarily with milk technology. He had mycological experience and had assembled an extensive collection of moulds. In 1943, with Joseph VonKennel and Joseph Kimmig, he wrote what is possibly the only article on antibiotics published in Germany during the war. It described the isolation of a number of strains of *Penicillium*, *Aspergillus*, *Fusarium* and *Cephalosporium*, all of which allegedly produced antibacterial substances that they named 'mykoins'. Kimmig, who had previously worked on novel sulfonamides, came to devote much effort to penicillin research and was supported by Schering AG. Hans Knöll, a microbiologist employed by the glass company Schott and Genossen, also provided strains to many other researchers. Elsewhere, at IG Elberfeld, Maria Brommelhues, working in Gerhard Domagk's (the pioneer of sulfonamides) laboratory had isolated some 50 strains of penicillia. She was aware that not all of the antibiotics produced by these strains were penicillin and she was able to separate the penicillin producers from those that produced other secondary metabolites such as notatin and patulin.

The practices and procedures described in Florey's second *Lancet* papers seem to have been widely adopted by most workers in Germany. In particular, penicillin was being bioassayed by variants of the method originally developed in Oxford by Norman Heatley. After 1942 the publication of process details in Britain and the United States on penicillin production was subject to strict control. Despite this, useful information got out into the public domain. More than one group of workers in Germany seems to have been aware that corn steep liquor had a beneficial effect on penicillin yields. Whether they knew quite what it was is a different matter; one contemporary reference called it 'mais-alkohol'. Most researchers in Germany used surface culture techniques for growing their strains. However, it emerges that a significant number of research workers had experimented with submerged culture with all its potential advantages, and Konrad Bernhauer at the University of Prague promoted this approach. Not surprisingly they reached the same conclusions as the American microbiologists at the Northern Regional Research Laboratories in Peoria, Illinois, namely that strains isolated on their ability to produce penicillin in surface culture are not necessarily able to produce similar yields in submerged culture. Details of the American programme were widely known about in Germany. An article in *Chemiker Zeitung* in October 1944 revealed to its readers the existence of the US War Production Board (WPB) and the names of American companies involved in penicillin production, as well as their production targets.

Whilst most of the technology employed in Germany for work on penicillin was based on Anglo-American developments, German workers also conducted original research. Not all of it was guaranteed to result in improved penicillin yields. When workers at the IG Hoechst works met persistent contamination, they countered with the use of ether and chloroform. More interestingly, some German microbiologists tried using mixtures of strains to increase penicillin yields. Others attempted to grow penicillia on waste liquors from paper mills. One entrepreneur named Bruno Bottcher developed an 'electro-osmotic diaphragm' technique for purifying penicillin. Schering AG were sufficiently impressed to supply Bottcher with penicillin transported from Berlin in vacuum flasks. Joseph Kimmig even attempted to understand how penicillin acted and although he arrived at an erroneous conclusion – that it disrupted the succinic acid cycle in bacteria – his work reveals a serious commitment to penicillin research. Heinz Oeppinger at IG Hoechst, interviewed

RIGHT:
Medical secrets. On 1 May 1946 Britain's secret wartime penicillin factory is revealed for the first time. Situated in Barnard Castle, Yorkshire, it was built under the auspices of the Ministry of Supply and Glaxo Laboratories Ltd.
FOX PHOTOS/HULTON PICTURE LIBRARY

immediately after the war by Harold Raistrick, apparently impressed Raistrick with his design for a 'rotating drum device' for submerged fermentation.

Organic chemists in Germany must have asked themselves, just as their counterparts in Britain and the USA did, whether they might not be able to synthesize penicillin chemically. The only information available to them was a formula for penicillin, subsequently shown to be incorrect, published in *Nature* by Heilbron and his co-workers in 1942. Publication of later Anglo-American work that led to the correct formula and synthesis was strictly controlled. German scientists never succeeded in purifying penicillin to enable meaningful structural studies to be carried out. One intelligence report describes with almost tangible incredulity how scientists at IG Marburg claimed that '*a small piece of moist-looking, orange-coloured, clumpy material*' was '*practically pure penicillin*'. Hopes of elucidating the structure of penicillin and then synthesizing it chemically probably explain the involvement of Richard Kuhn. Kuhn had been nominated for the Nobel Prize in 1938 for his work on the structure of vitamins and carotenoids, but forbidden by a decree of Hitler's from accepting it. Kuhn had been working on synthetic antibacterials, and claimed that one of his compounds, 3065 [bis(5-bromo-2-hydroxyphenyl)ethanedione] was allegedly 300 times more potent than penicillin. His penicillin was from the German War Ministry that had captured Allied penicillin manufactured by Burroughs Wellcome, at an unknown date and place, and of uncertain activity. Kuhn was correct in that 3065 does have antibacterial activity, but his conclusions about its efficacy compared to penicillin were certainly wrong. As Head of the Kaiser Wilhelm Institute in Heidelberg, Kuhn was in an influential position and his findings must have fuelled German suspicions that the power of penicillin had been exaggerated by the Allies for propaganda reasons.

Heatley's assay technique, widely used in Germany, would have detected any antibiotic substance that inhibited the growth of the assay bacterium, *Staphylococcus aureus*. With penicillia being isolated from a variety of sources by several groups of workers, it seems possible that some researchers in Germany may not have been working with penicillin, but with other secondary metabolites. Some in Germany understood this. After the war, Canadian microbiologist Roger Y. Stanier was charged with preparing a report for BIOS on applied microbiological research in Germany and met and interviewed a number of German scientists. Andreas Lembke told him that at least one of the mykoins he had isolated – mykoin C – was chemically distinct from penicillin. Lembke cited the fact that mykoin C's spectrum of antibacterial activity was distinct from that of penicillin. As further evidence, he told Stanier that it was not inactivated by penicillinase. Kuhn had not been the only scientist to receive captured Allied penicillin, and it is quite possible that Lembke was able to reach his conclusions because he had access to some '*authentic*', but low potency, penicillin. Stanier's curt assessment was that mykoin C was probably '*a mixture of clavacin with some penicillin*'.

Some penicillin was certainly produced in Germany, although never on a sufficiently large scale for strategic value. Theodore Morell's diaries show that penicillin was used by him to treat Adolf Hitler's injured hand following the July 1944 bomb plot. The penicillin may have been produced at Olomutz in Czechoslovakia, a facility that had been seized from its original Jewish owners and placed under Theodore Morell's control. Morell's actual contribution to penicillin work was insignificant, but he employed two scientists of Jewish ancestry, Kurt Mulli and Wolfgang Laves to supervise work at the plant. Morell went on to receive the Iron Cross in 1943 for the discovery of 'bacteriostatic substances from the lower fungi'. Information about this came to the attention of the press in Britain and *The People* ran a story headed '*Huns steal new drug*'. References to clinical trials occur a number of times in the BIOS and CIOS reports, although some researchers appeared unwilling to submit their impure material for trials. Learning from Lembke that some of the antibiotics he had produced were sent to a hospital in Segebeck for clinical trials, Stanier took himself there. He was unimpressed with what he found and although the clinicians at Segebeck provided accounts of the penicillin's efficacy in treated dermatological conditions, Stanier concluded that no meaningful clinical trials had been carried out. Hoechst claimed to have manufactured a number of penicillin-containing products, including '*penicillin wound powder*' and penicillin impregnated

bandages, neither of which, they hastened to add, were ever supplied to the German armed forces.

The ultimate failure of German efforts

Why did the German programme not succeed in producing useful quantities of penicillin? Immediately after the war the technical intelligence teams touring Germany attributed this failure to an over-reliance on the sulfonamides. Although these were important products for the German pharmaceutical industry, this conclusion now appears too simplistic. Penicillin research was taking place in Domagk's own laboratory under Maria Brommelhues and even Joseph Kimmig, who owed his scientific reputation to the sulfonamides, became a convert to penicillin.

As the first antibiotic, penicillin heralded a new era for pharmaceutical companies where successful production demanded application of established technology – fermentation – to the production of an entirely novel compound. In the United States the experience of the fermentation industry was rapidly and efficiently mobilized by the WPB to the services of penicillin production. The main industrial participants in German penicillin work were the constituent companies of IG Farben, Schering and Merck. These had all achieved notable success with synthesized compounds, but found the change in methodology difficult to make, despite the considerable fermentation experience that existed in Germany. The country had been at the forefront of fermentation technology from before the First World War, when a substantial proportion of their fodder requirements were met by yeast grown specifically for the purpose. In the inter-war years the fodder yeast industry had declined, but in 1939 it again assumed a strategic significance. Some companies conducted their operations in fermentation vessels of 600 m^3 capacity. The failure to bring together existing fermentation experience and the considerable fermentation capacity in Germany proved costly.

Whilst it is clear that useful collaborations between different research workers and companies were established, it is also evident that there was wasteful duplication of effort. The absence of a central reference laboratory was a definite disadvantage. Microbiologists may have been freely exchanging strains, but there seems not to have been any systematic attempts to identify the most productive ones. Whilst Heatley's assay was in general use, there appeared to have been no attempts to standardize the technique throughout Germany. At the IG Elberfeld works, the scientists told their Allied interrogators that they were producing penicillin of a potency of 40 Oxford units. However, on further questioning they were forced to admit that the potency was in reality 40 'Elberfeld' units. In contrast, Florey took Heatley with him to the USA in 1941 specifically so that he could instruct the microbiologists at Peoria on the finer points of his assay.

The costs of the American programme to produce penicillin were estimated at about $14 million. Unfortunately no comparable data exists for the uncoordinated German effort, but it was certainly considerably less. One account refers to Richard Kuhn as having received 25,000 Reichsmarks (approx. $10,000) for '*research on antibacterial compounds*'.

Both the British and the American wartime programmes owed their success to central co-ordination. German realization of the need to co-ordinate the many disparate activities came too late. Heinz Oeppinger was present at a meeting held under the Chairmanship of Professor Paul Rostock in which Konrad Bernhauer was put in charge of a co-ordinating committee. Oeppinger said that '*by the time of that meeting, we could get no yeast, no acids, no supplies or materials. It was all over.*'

● *Dr Gilbert Shama is a Lecturer in the Department of Chemical Engineering, University of Loughborough, Loughborough, Leicestershire, LE11 3TU, UK.*
Tel. 01509 222514; Fax 01509 223923
email g.shama@lboro.ac.uk

Further reading

Bud, R. (1993). *The Uses of Life. A History of Biotechnology*. Cambridge: Cambridge University Press.

Forth, W., Gericke, D. & Schenk, E.-G. (1997). *Von Menschen und Pilzen*. Munich: W. Zuckschwerdt.

Mateles, R. I. (1998). *Penicillin: A Paradigm for Biotechnology*. Chicago: Candida Corporation.

Pieroth, I. (1992). *Penicillinherstellung Von den Anfängen bis zur Grossproduktion*. Stuttgart: Wissenschaftliche.

Shama, G. & Reinharz, J. (2002). Allied Intelligence reports on wartime German penicillin research and production. *Hist Stud Phys Biol Sci* 32, 347–367.

Severe Acute Respiratory Syndrome (SARS)

Faye Jones

In mid-March 2003 the World Health Organization (WHO) issued emergency guidance for travellers and airlines in the light of '*a worldwide health threat*' from a new infectious disease called Severe Acute Respiratory Syndrome (SARS). This infection, which was mainly affecting people in the Far East, started with 'flu like symptoms and rapidly turned to pneumonia. Thought to be caused by a virus, SARS defied treatment and was proving fatal in many cases. Since this announcement the disease has spread to many other countries, fuelling much media hysteria and general panic. As we go to press, the WHO has announced that the worst is over. Faye Jones, SGM Public Affairs Administrator, has chronicled the whole story week by week on the SGM website (**www.sgm.ac.uk/news/hot_topics/sars.cfm**). Here is her summary of what has been dubbed '*the first global epidemic of the 21st century*'.

A brief history

Outbreak. The SARS outbreak is thought to have originated in the Guangdong province of southern China in mid-November, last year. Over 300 people were taken ill with a new infectious disease and 5 people died. In February this year, a doctor fell ill whilst attending a wedding in Hong Kong. He had been treating the patients in Guangdong. It is believed that he infected several guests who were staying in the same Hong Kong hotel, as well as medical staff, after being admitted to hospital. He later died of the infection.

Out of Hong Kong. The disease then spread outside Hong Kong with the infected hotel guests. These included Singaporeans, Canadians and a Chinese-American businessman. The businessman travelled from Hong Kong to Hanoi, Vietnam, and fell ill a few days later, infecting hospital workers there. The World Health Organization (WHO) asked Carlo Urbani, an infectious disease specialist, to advise in Vietnam. He realized the disease was something new and called it Severe Acute Respiratory Syndrome (SARS). Due to his close work with SARS patients, Carlo Urbani himself became infected and died in March.

Teamwork required. The WHO began to co-ordinate a number of international laboratories to work together to find the cause of the disease. Microarray analysis on samples indicated that a coronavirus was the cause of the disease. In particular, they observed a strong link between the SARS virus and two other coronaviruses: avian infectious bronchitis virus and a bovine coronavirus. At this time, there were already two known human coronaviruses, 229E and OC43. These caused between 5 and 30 % of common colds and could also cause intestinal infections.

PHOTO DIGITALVISION

Genome of SARS agent revealed. By April, scientists in Canada and the US had both sequenced the genome of the virus most linked with SARS. Their results confirmed the cause as a coronavirus, different from all those previously known. The cause of SARS has now been documented by the WHO as SARS coronavirus (SARS CoV).

Coronavirus. Coronaviruses are enveloped, single-stranded RNA viruses. They have a genome of approximately 30 kilobases, the largest of the RNA viruses. This family of viruses is named for their crown-like appearance, which is due to an array of surface projections on the viral envelope. Typically, they have a narrow host range and they replicate in the cytoplasm of the host epithelial cells.

Symptoms

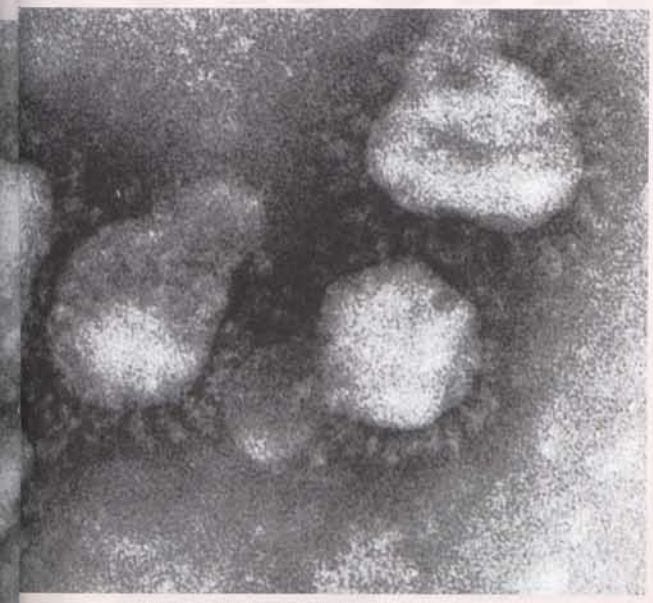
SARS is an atypical pneumonia, with symptoms that are 'flu-like. These include high fever (greater than 38 °C), aching muscles, chills, sore throat, headache, dry cough, shortness of breath, breathing difficulties, and in a number of cases, diarrhoea. Research published in *The Lancet* suggested that SARS CoV kills 1 in 5 people infected. Those aged over 60 are most at risk, with over half those infected dying; the death rate is about 7 % in those aged under 60. The incubation period is 2–10 days, and the infectious period does not start until the onset of symptoms. Antibodies to SARS have been detected in patients from about 10 days after the start of clinical symptoms.

Diagnosis

Early on in suspected cases, the presence of the SARS CoV polymerase gene is detected using the polymerase chain reaction (PCR). Much later on in infection, the immune system produces antibodies to the virus, which allows serological methods of detection to be employed.

Treatment

There is currently no cure for SARS. Some patients have been treated with a non-specific antiviral drug, ribavirin. In addition, many have been given steroids to reduce the severe inflammatory response to the infection. Others have been put on life-support in the hope that their own immune system will combat the infection. In Hong Kong, some severely affected patients were treated with antibodies taken from recovered patients.



LEFT:
Electron micrograph of the SARS virus, negatively stained with phosphotungstic acid, at an approximate magnification of x320,000.
COURTESY HAZEL APPLETON, HEALTH PROTECTION AGENCY

Spread of the disease

Direct contact with someone suffering from SARS appears to be required for spread of the disease. This is seen by the fact that mainly healthcare workers or close family and friends of patients are infected. The WHO has stated that SARS is spread by prolonged direct contact or by large exhaled droplets of body fluids. The organization has ruled out spread by smaller aerosol droplets, as this would have led to a much higher number of cases. SARS CoV has been shown to survive for up to 48 hours on plastic surfaces and up to 4 days in diarrhoea. It is thought to spread like colds and 'flu, and as such, experts have recommended frequent hand washing. The virus loses its ability to infect after exposure to a number of commonly used disinfectants.

SARS source

The source of the SARS virus was a mystery for quite a while. Early on in the outbreak it was believed that the virus may have come from pigs or chickens and mutated to infect humans. However, attempts to infect these animals with the SARS virus failed. Then, despite there being no scientific evidence for it, fears grew in China that pets were the hosts for SARS, leading to extermination patrols killing hundreds of cats and dogs.

Finally, the source of SARS CoV was revealed to be the masked palm civet. This cat-like mammal is related to the mongoose, and is regarded as a delicacy in Guangdong province where the outbreak first originated. Microbiologists at the University of Hong Kong checked large numbers of domestic and game animals to try to find the cause of SARS. It is believed that the virus jumped to humans as they raised, slaughtered and cooked the animals, rather than from eating infected meat. Virus samples very similar to coronavirus were isolated from the faeces and respiratory fluids of four individual civets. This information should help prevent further outbreaks through controlling the sale and slaughter of these animals in China.

Vaccine development

Studies in *The Lancet* show that the SARS virus is not mutating as expected. This news is likely to make the design of a vaccine to prevent further outbreaks much easier.

Lessons

During this outbreak of SARS, over 30 countries worldwide have reported probable cases of infections. Tens of thousands of people have been either directly or indirectly affected by the disease, from contracting the illness itself to public holiday cancellations, school closures, and, in the worst affected areas, 10-day voluntary quarantines for many thousands of residents.

Since March, the WHO has continued to issue travel bans on the worst affected areas, lifting them when it was considered safe. This has had an economic impact on many industries, particularly travel and tourism.

After it was revealed that China had initially underreported cases of SARS, the disease spread out of control there. In Canada, it was announced that SARS was under control and no longer spreading. No new cases had been reported there for over 4 weeks, that was, however, until it resurfaced in May with at least 20 new cases. Alan Milburn, the UK Health Secretary, has said that he wants international law to be strong enough to ensure that demands by the WHO in relation to such outbreaks are carried out by all countries.

The figures (from the WHO) for 20 June 2003 put the number of probable cases of SARS at 8,461, with the number of deaths at 804.

Further information

WHO
http://www.who.int/csr/sars/en/
Contains the latest information on SARS symptoms, affected countries and travel advice.

UK Department of Health
http://www.doh.gov.uk/sars/index.htm
Contains the latest UK travel information, as well as answers to FAQs.

UK Health Protection Agency
http://www.phls.org.uk/topics_az/SARS/menu.htm
Has information on SARS for healthcare professionals as well as for the public.

Faye Jones, SGM Public Affairs Administrator

A fuller bibliography on SARS and the whole detailed story of the outbreak is available on the SGM website Newsdesk (www.sgm.ac.uk). For a virologist's opinion on SARS, see *Comment on p. 152.*

SocietyNews

May Council Meeting

Finance matters

● I suspect that many of our members rather take for granted the smooth running of the Society and the quality of its scientific meetings, but it is worth remembering that in fulfilling its responsibilities as a charitable organization promoting microbiology, much depends on the financial management overseen by Council and our Treasurer in particular. At a time when stock markets have been in turmoil, the Society has not been immune and Council heard that it has sustained an unrealized loss of £1·4 million in its reserves in 2002 due to falling markets. However, the strong commercial performance of our journals in 2002 and careful control of expenditure has enabled the Society to continue with its full range of activities for the foreseeable future.

Biosciences Federation

● Council learned that the formal launch of the new Federation will take place at the Houses of Parliament on 15 September at a reception, which will also mark the award of the Nobel Prize in physiology or medicine to Sir John Sulston and Dr Sydney Brenner.

Schools Poster Competition

● Council enjoyed viewing the winners and some of the 1,000+ other posters submitted by schools in the recent MISAC competition, sponsored by SGM. We were very impressed with both the overall quality and creativity as well as the sheer hard work that had clearly gone into many of the posters. See p. 132 for further details.

SGM and the media

● Council was pleased to note the increasing profile of its media coverage associated with the Edinburgh Meeting in April. Articles resulting from our press releases had featured in *New Scientist* for three weeks running as well as in BBC On-line and numerous other publications.

Policy on publication and bioterrorism

● Council approved as Society policy a statement on Scientific Publication, Security and Censorship which can be found on our journal websites and on p. 128.

Regional Meetings joint with SfAM

● Following the success of the first of these meetings in Plymouth in March, Council was pleased to hear that a further meeting on *Transport in Soils and the Environment* will take place at Lancaster on 18 September (for details see p. 131).

● *Alan Vivian, General Secretary*

News of Members

Congratulations to **Joanna Verran**, Convener of the SGM Education and Training Group, on her appointment as Professor of Microbiology at Manchester Metropolitan University.

Congratulations also to **Dr Tim Wreghitt**, Convener of the Clinical Virology Group, whose photograph amongst some greenery at Chelsea Flower Show appeared in the *Times Higher Education Supplement*. This resulted from his contribution to the Royal College of Pathologists' silver medal-winning display in the lifelong learning marquee 'Pathologists and plants working in partnership'.

The Society notes with regret the death of **Professor Brian M. Wilkins** (Member since 1979).

Staff News

We are pleased to welcome **Dr Faye Jones** as new Public Affairs Administrator in the External Relations team. Faye gained her BSc at the University of Teesside, followed by a PhD at the University of Aberdeen. She has recently returned to the UK after a spell as a postdoc in Maryland, USA. Faye will be helping to promote microbiology to opinion-formers and government, as well as issuing media releases and handling enquiries from the press. She is also responsible for the content of the *Newsdesk* section of the SGM website. She would welcome further volunteers for inclusion in the database of experts willing to comment on their specialism in response to consultations and other enquiries. She can be contacted by emailing pa@sgm.ac.uk or phoning +44 (0)118 988 1843.

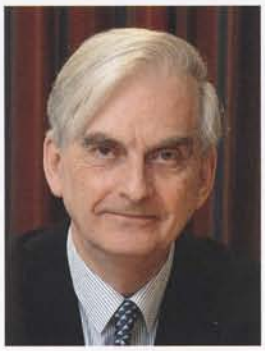
Congratulations to **Robin Dunford**, Deputy Managing Editor of JMM and IJSEM, and his wife Angela, on the birth of their second daughter, Clara Eluned Grace, on 15 April.

Annual General Meeting 2003

The AGM of the Society will be held on **Tuesday 9 September** at the Society meeting at UMIST. Agenda papers including reports from Officers and Group Conveners and the accounts of the Society for 2002 are in the separate Annual Report booklet distributed to all members with this issue of *Microbiology Today*.

New President

Hugh Pennington



Hugh Pennington trained in medicine at St Thomas's Hospital Medical School in London. It excelled in producing two medical phenotypes, Harley Street specialists and academic cynics. Membership of the latter was sealed by a house job with Professor Edward Sharpey-Schafer, a brilliant rude iconoclast who published many papers without repeating himself.

Entry into microbiology came unexpectedly with a job offer from Professor Ronald Hare at Thomas's. He had worked with Alexander Fleming, discovered influenza virus haemagglutination, and set up a pioneer penicillin factory in Canada. His polymathic applications of science to practical ends were attributes to emulate. A PhD on virulence in Newcastle disease with Tony Waterson, Hare's successor, followed. Molecular methods were neonatal; making gel kits from sandwich boxes, red-hot glass rods, wire from bacteriological loops and grommets from radio spares was fun; NDV was a brilliant introduction to the rich world of veterinary pathogens. Particularly influential at Thomas's was June Almeida, the all-star electron microscopist (and describer of coronaviruses).

After a spell in the US, contact with the MRC about jobs in the tropics resulted in a response from John Subak-Sharpe's Glasgow Virology Unit. Even for a poxologist, which Hugh became, its intellectual and infrastructural support was fantastic.

After an appointment to the bacteriology chair at Aberdeen in 1979, applying modern methods routine in virology to bacterial pathogens, was too good an opportunity to miss. Molecular epidemiology was a must. One result was an invitation from the Secretary of State for Scotland to chair an inquiry into the 1996 central Scotland *E. coli* O157 outbreak. Hugh had been Dean and thought he understood politics. Scales fell from his eyes when he saw civil servants and ministers interacting behind the scenes. It was also the start of a fairly intense relationship with the media.

Hugh was elected FRSE in 1997 and FmedSci in 1998. He sits on committees advising the Food Standards Agency and the BBC. He believes that scientists face big challenges because the ever increasing expectation that science has a ready answer to every problem is counterbalanced by a simultaneous loss of trust in experts, exacerbated by BSE. So the work of the SGM has never been so important. If microbiologists can match the impact on government policy and public opinion of the microbes they study, he will be well pleased.

The Society notes with regret the death at the age of 86 of **Professor Sir Robert Williams**, medical microbiologist and Honorary Member of the SGM. Sir Robert, once Dean of St Mary's Hospital Medical School and Director of the Public Health Laboratory Service for England and Wales, was greatly admired.

New Education Officer

Sue Assinder

Sue became interested in microbiology when she worked with the fungus *Aspergillus nidulans* during her final year project at the University of Lancaster. She continued with this research for her PhD, and then transferred to prokaryotes for a few years during postdoctoral positions in Nova Scotia and Bangor. She was appointed to a lectureship in Bangor in 1989 and will become Head of School in August. She maintains an interest in fungi, particularly in the molecular genetics of hyphal tip growth.

Sue's new role as SGM Education Officer reflects a strong interest over many years in promoting public engagement with science. She has been Education Secretary of the British Mycological Society for the past 4 years. She regularly participates in events for schools and the public and helps to organize the annual Wrexham Science Festival. She won the BBSRC Science Communicator Award in 1995 for her teacher's guide *DNA – The Recipe for Life* and has recently co-authored a children's activity book *How the Mushroom got its Spots*.

Sue enjoys walking, cycling and family life with her husband and three teenage children.

SGM Prizes and Lectures

Peter Wildy Prize for Microbiology Education

Dr R.A. Killington

Title of Lecture: *Walking with the viruses*

Dick Killington was born in Norwich and remains, 'sadly' a supporter of the Canaries. His first degree and subsequent PhD was carried out in Harry Smith's Microbiology Department at the University of Birmingham, where he was taught virology by Peter Wildy! Dick's postdoctoral fellowship was with Drs David Tyrrell and Jim Stott at the MRC's Clinical Research Centre, Harrow, where he studied rhinoviruses.

In 1972 he was delighted to join Douglas Watson's Microbiology Department at the University of Leeds as a lecturer in virology, researching into herpesviruses. He is now Head of Microbiology at Leeds and his research interests, in collaboration with Dave Rowlands, have reverted to picornaviruses!

Dick is enthusiastic and passionate about teaching and sees his main objectives as motivating undergraduates to reach their optimal levels of achievement. He is the co-author of three microbiology textbooks and an active member of a number of student support networks at the University of Leeds.

History of Microbiology Lecture

Dr Soraya de Chadarevian

Title of Lecture: *Origins and Birthdays: the double helix fifty years on*

Soraya de Chadarevian studied biology at the University of Freiburg and obtained a PhD in philosophy at the University of Konstanz. She then turned to the history of science and in 1991 was hired to a Wellcome Unit Project at the Department of History and Philosophy of Science in Cambridge to work on the history of molecular biology in Britain. She continues working on this and allied projects in the same institution where she also teaches. Recent publications include *Designs for Life. Molecular Biology after World War II* (Cambridge University Press 2002) and two co-edited volumes, *Molecularizing Biology and Medicine. New Practices and Alliances, 1910s–1970s* (Harwood Academic Publishers 1998) and *Models. The Third Dimension of Science* (Stanford University Press, in press). She co-curated the exhibition *Representations of the Double Helix*, currently on show in the Whipple Museum of the History of Science at Cambridge.

Fred Griffith Lecture

Prof. S. Cohen

Title of Lecture: *The many faces of bacterial plasmids in microbiology and genetics*

It had long been believed that natural barriers to interspecies mixing would prevent DNA from one species from being propagated in another. However, while carrying out investigations of the molecular nature of bacterial antibiotic resistance plasmids in the early 1970s, Cohen and his colleagues discovered that genes from virtually any source can be cloned by linking them to DNA molecules that can replicate in the intended host. The invention of DNA cloning has enabled studies of gene structure and function at the molecular level and the building of cellular 'factories' that produce medically and biologically important proteins.

Cohen attended Rutgers University as an undergraduate and received his doctoral degree from the University of Pennsylvania. His postdoctoral training was at the US National Institutes of Health and in the laboratory of Professor Jerard Hurwitz. Since 1968, he has been a member of the Stanford University faculty where he is currently Professor of Genetics and holds the Kwoh-Ting Li Professorship in the School of Medicine.

Microbiology technician survey results

As part of a general review, Council is assessing whether Society activities meet the requirements of all microbiologists. They particularly wish to encourage microbiology technicians in universities and hospitals to become members, but first needed to find out their views on the SGM. To this end, the External Relations Office distributed a questionnaire to microbiology departments around the UK. We were pleased to receive a positive response from microbiology technicians with a wide range of experience.

Responses to the survey indicate that the interests of university-based microbiology technicians are not currently represented by any professional body or learned society. Almost half of the respondents would be interested in joining the Society and the majority are keen to attend future SGM meetings.

The survey results will be considered at the President's Strategy Group meeting in the summer and recommendations arising from the discussion will be made to Council.

Grants are still available for the UMIST meeting from the Technicians' Meetings Taster Grant scheme. This enables eligible microbiology technicians in universities, hospitals, research institutes, etc., to sample an SGM meeting with expenses of up to £200 being met by the Society. Full details are available on the SGM website. Applications must be submitted to the grants office on the appropriate form before the meeting. Please do promote this opportunity to sample an SGM meeting to technical staff in your department.

Policy on Scientific Publication, Security and Censorship

SGM Council considered its policy on scientific publication, security and censorship at its meeting on 21 February 2003, in the light of recent concerns about potential use of micro-organisms and toxins for bioterrorism. Opinions amongst other learned societies and publishers tended to be polarized between those who felt that journals should have some editorial guidelines to prevent the publication of material of potential use by terrorists and those who wished to resist any form of censorship and restriction of research. Council agreed to prepare a written policy on this issue, which was then circulated for comment. The final version was approved at the Council meeting on 2 May. The official statement, which will appear on all SGM journal websites is as follows.

1. Scientific publication is important for the communication of ideas and findings, for the improvement of human, animal and plant health, and safeguarding of the environment.
2. The integrity of the process of publishing articles in peer-reviewed journals must be protected. Articles must be published in sufficient detail to permit the experiments to be repeated in other laboratories, as a means of independent verification and a basis for further advances.
3. There is already a great amount of information in the public domain, such as the sequences of the genomes of many pathogens, which could conceivably be exploited by a determined bioterrorist. The same information has also been exploited for public benefits, including biodefence and health protection. The benefits greatly outweigh the potential dangers.
4. SGM Council is against any blanket or external censorship of scientific publication in subject areas such as microbiology, as this would be a barrier to scientific progress. Furthermore, the potential benefits or dangers from a new discovery are not always possible to predict.
5. Nevertheless, it is responsible to recognize that in rare cases, papers submitted for publication might raise particular concerns that the methods or results could have possible use in bioterrorism.
6. In consequence, authors, editors, referees and publishers should be prepared to consider safety and security issues of presentation and publication, if it appeared that an aspect of a paper might be readily exploited to enhance the capacity for bioterrorism. The final decision should be the responsibility of the Editor-in-Chief of the journal concerned, advised by its Editorial Board. SGM Council should keep its policy and processes for implementing it under review.

The overall reasoning in paragraphs 1–6 also applies to any proposals for further restriction and regulation of experimental work with pathogens and toxins, and of international scientific collaborations. Control of such matters rests with universities and research institutes, etc., and the relevant regulatory authorities, rather than with SGM Council. However, the point is made on behalf of microbiology as a science and profession, that excessive regulation could have negative consequences.

SGM Members elected Fellows of the Royal Society

Congratulations to the following SGM members who were elected Fellows of the Royal Society recently. Fellows are elected for their contributions to science, both in fundamental research resulting in greater understanding, and also in leading and directing scientific and technological progress in industry and research establishments. A maximum of 42 new Fellows are elected each year.

Professor Jeffery Errington
Professor of Microbiology, University of Oxford

Jeff Errington has made notable contributions to our understanding of cell differentiation and cell division exploiting the sporulating bacterium *Bacillus subtilis*. He developed a bacteriophage into the only efficient cloning system for this widely studied organism, and with it cloned nearly all the regulatory genes essential for sporulation. He showed that two novel transcription factors, σE and σF, determine differential gene expression and hence different cell fates in the two cells generated by the cell division event that precedes sporulation. He pioneered the application of high-resolution fluorescence microscopy to the localization of molecules in tiny bacterial cells and thereby overturned the widely held view of passive, cell-growth-associated chromosome separation in dividing rod-like bacteria. Instead, he showed that an active mitotic-type of mechanism engages a centromere-like sequence near the origin of chromosome replication, and that the completion of DNA partitioning during cell division involves a process resembling DNA transfer during bacterial matings.

Professor Keith Gull
Wellcome Trust Principal Research Fellow, Sir William Dunn School of Pathology, University of Oxford

Distinguished for his contributions to our understanding of the cell and molecular biology of eukaryotic microbes, especially fungi, slime molds and trypanosomes. His work has provided important insights into how cells construct their cytoskeletons by modulating tubulin gene expression and protein modification. His novel approaches have led to the discovery of unusual mechanisms of microtubule initiation and the partitioning of genomes in sleeping sickness trypanosomes, and also of the relationship of division to differentiation in these parasites. His discovery of the mode of action of the antifungal agent griseofulvin has been followed by explanations of the selective toxicity and resistance mechanisms of fungicides and anthelminthics.

Professor Geoffrey Smith
Professor of Virology, Imperial College London

Distinguished for his research on vaccinia virus, especially for his analyses of its genome structure in relation to enzymes involved in its replication, and to the processes by which it modifies immune responses to infection, and for his contributions to the development of recombinant vaccinia vectors and their use in immunological research. His initial construction of vaccinia recombinants containing genes from hepatitis B virus and from influenza viruses was important in defining, in collaborative experiments, the antigens recognized by immune T cells. Subsequently his observations that vaccinia encodes an enzyme involved in steroid formation and a family of serpin protease inhibitors contributed to an understanding of the mechanism of suppression of inflammation in virus infections. Most importantly his discovery that the virus encodes a soluble type 1 interferon receptor with high affinity for IFN-α/β and broad species specificity, and a similar soluble IFN-γ receptor, were important demonstrations that pox viruses employ cytokine receptors to evade immune processes and emphasized the importance of interferons in the response to virus infections.

The following former member was also elected:

Dr Karen Vousden
Director, Beatson Institute for Cancer Research, Glasgow

Distinguished for her studies on the p53 and Rb tumour suppressor genes whose functions are disrupted in most human cancers.

Grants

The full rules of all Society grant schemes are available on the SGM website at **www.sgm.ac.uk**. Please consult these before applying for an award. You can download the application forms for schemes where these are required. Click on the 'Grants' button for details.

Any enquiries should be made to the Grants Office, SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG [Tel: +44 (0)118 988 1821; Fax: +44 (0)118 988 5656; email: grants@sgm.ac.uk].

International Research Grants

This scheme allows scientists to travel from or to the UK/Republic of Ireland to carry out a defined piece of research in any field of microbiology. Applicants must be of senior postdoctoral level or above. The visits may be from one to three months duration. The awards cover the costs of return travel, a subsistence allowance and a contribution towards the costs of consumables in the host laboratory. The closing date for applications is **10 October 2003**.

International Development Fund

Members are reminded that funding is again available for competition this year. The purpose of the Fund is to assist microbiologists in countries where microbiology is inadequately developed. Members may apply for funding to run training courses in developing countries appropriate to the needs of those countries, or for any other small project to assist in technology transfer from developed countries. The closing date for applications is **10 October 2003**.

Watanabe Book Fund

Members who are permanently resident in a developing country are reminded that they may apply for funding to acquire for their libraries books, or possibly journals, relating to microbiology. These annual awards are available as a result of a generous donation from Professor T. Watanabe of Japan. The closing date for applications to the Grants Office is **3 October 2003**.

Seminar Speakers Fund

The Fund aims to promote talks on microbiological topics in departmental seminar programmes. Applications are invited from higher education institutions where microbiology is taught for grants of up to £200 towards the travel and, if necessary, accommodation expenses of an invited speaker. Applications will be dealt with on a first come, first served basis during the academic year. Written submissions should be sent to the Grants Office for consideration.

Education Development Fund/PUS Awards

Dr Lesley Manchester, University of Aberystwyth, has been awarded up to £1,500 to develop microbiology posters for Welsh schools.

Grants are available from this fund to members for projects intended to lead to an improvement in the teaching of any aspect of microbiology relevant to education in the UK. This might include the development of teaching materials (e.g. videos, slides, posters, CAL packages) or novel practical exercises. Funding is also available for small projects to promote the public understanding of microbiology, such as workshops, talks, demonstrations, leaflets, activities at science festivals. Applications will be considered on a first come, first served basis during the calendar year 2003.

SGM Undergraduate Prizes

Nominations are invited from higher education institutions for the undergraduate student who performs best in microbiology in their penultimate BSc year. Each student is awarded £50, a certificate and a free year's undergraduate membership of the Society. The prizes are intended to encourage excellence in the study of microbiology by undergraduates and to promote scholarship in, and awareness of, microbiology in universities. Nomination forms were sent out to departments in early June, but further copies may be downloaded from the SGM website. The closing date for the receipt of applications by the Grants Office is **31 August 2003**.

Retired Member Conference Grants

Retired members are reminded that they may now apply for a grant to attend one SGM conference each year. The award covers en-suite accommodation and the Society dinner, up to a maximum of £250. Applications for grants to attend the SGM meeting at UMIST are now invited.

Vacation Studentships

These enable undergraduates to work on microbiological projects during the summer vacation before their final year. They are intended to provide undergraduates with experience of research and to encourage them to consider a career in a laboratory-based science. Support is provided at the rate of £150 per week for a maximum period of 8 weeks. Up to £400 may also be awarded towards the cost of consumables. Students are required to submit a brief report of their research on the completion of the studentship. The scheme has proved to very successful. This year 59 applications were received (five more than in 2002) and studentships were offered to 39 applicants. A list of awardees is available from the SGM Grants Office on request.

Council has set aside a further sum to fund vacation studentships next year. Full details of the scheme will be announced in the next issue of *Microbiology Today* and published on the SGM website.

SGM journals: are they in your library?

The SGM now has an impressive stable of four journals, when not long ago the Society published only *Microbiology* and JGV. The takeovers of JMM and IJSEM have added considerably to the breadth of microbiology we cover, reflecting the SGM's aim to support all areas of our discipline. The international standing of the journals is unquestioned, with excellent editorial boards in control of the content and superb professional staff at Marlborough House using the latest technology to facilitate the process from manuscript to print. The recent makeover of the cover and internal design of the journals in a common style has produced not only an attractive 'brand image' of high quality, but more easily navigable publications in both print and on-line formats.

The journals are a core activity of the Society and fulfil its charitable aims to advance the science of microbiology by keeping scientists aware of the latest research findings. However, the journals are also important to SGM as the main source of income with which to fund all its other activities to promote microbiology, such as meetings, grants and educational initiatives. In a world of shrinking library budgets and global site licences for on-line access, SGM journals although undoubtedly excellent, have many competitors. Institutional sales are vital to the Society and whilst the journal sales team work hard to find new markets and maintain existing subscriptions, they would really appreciate some help.

Librarians usually base their decision on whether or not to buy a journal subscription on the recommendations of academics in their institution. By raising the profile of SGM journals to the relevant people in your organization, you can help to ensure not only that they are available in print and on-line to all the staff there, but that YOUR professional society can continue to provide all the benefits and services that make it such a great force in promoting microbiology.

Please do all you can to endorse our journals. Promotional leaflets are available from Marlborough House – contact jsales@sgm.ac.uk if you would like copies.

Meetings

Meetings on the web

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

Meetings organization

The SGM meetings programmes are organized by the committees of the special interest groups, co-ordinated by the Scientific Meetings Officer, **Professor Howard Jenkinson**. Suggestions for topics for future symposia are always welcome. See p. 148 for contact details of Group Conveners.

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

Offered papers and posters

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

Offered posters

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

Abstracts

Titles and abstracts for all presentations are required in a standard format and should be submitted through the SGM website. Each submission must be accompanied by a completed form also available on the website. Deadlines for submissions are published in *Microbiology Today* and on the web. For further information contact the Events Administrator.

Future Meetings

AUTUMN 2003 – 153rd Meeting

UMIST, Manchester
8–11 September 2003

celebrating life
DNA DOUBLE HELIX 1953-2003

● Main Symposium
Exploiting genomes: bases to megabases in 50 years

Organizers: H.F. Jenkinson, D.J. Kelly, P.C.F. Oyston, J. Parkhill & I.C. Sutcliffe

● Programme Booklet

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

● *Young Microbiologist of the Year* finals

9 September

This competition is sponsored by the Society to encourage excellence in scientific communication by young microbiologists. Group Committees have now judged recent oral or poster presentations by members who are postgraduate students or postdocs who have gained their PhD in the past two years. The finalists from each Group go forward to compete for prizes at a special session of short oral presentations on their research. The best three entries win cash prizes:

- 1st: £500
- 2nd: £200
- 3rd: £100

All finalists receive a year's free Society membership.

● 'History of Microbiology' Lecture

1800, 10 September

Renold Building, UMIST

Origins and Birthdays: the double helix fifty years on

Speaker: Soraya de Chadarevian, University of Cambridge

It is now generally accepted that Watson and Crick's presentation of their double helical model of DNA in 1953 did not create a stir right away. In the 1950s, scientific reference to the paper was scant and quickly declined, the media took hardly any notice and not even the term 'double helix' was current before James Watson's best-selling book carried that title. How then can we explain the central role the double-helical model of DNA and the story of its discovery has come to play in scientific circles as well as in the public presentation of the science? Clues to the answer can be found in the history of the discovery and its presentation as well as in the wide range of events staged for the fiftieth anniversary of the now famous molecule.

This lecture will be open to the public.

SPRING 2004 – 154th Meeting

University of Bath
29 March–2 April 2004

● Main Symposium
Microbe–vector interactions in vector-borne diseases

Organizers: S.H. Gillespie, H.F. Jenkinson, A. Osbourn, P.C.F. Oyston & R.E. Randall

● Speakers

29 March

B. MAHY (NCID, USA)
Vector-borne diseases

S. RANDOLPH (Oxford)
Evolution of tick-borne diseases

S. BLANC (Montpellier, France)
Insect transmission

S.W. DING (Riverside, USA)
Interactive silencing of host gene expression

A.G. BARBOUR (Irvine, USA)
Reducing the prevalence of Borrelia in ticks

B. BEATY (Colorado, USA)
Bunyavirus/mosquito interactions

S. HIGGS (Texas, USA)
How do vectors live with their viruses?

S. WEAVER (Texas)
Induction of vector competence

30 March

P. MELLOR (Pirbright)
Climatic change

N. RATCLIFFE (Swansea)
Immune systems in vectors

S. MACFARLANE (SCRI, Dundee)
Nematode transmission

M.J. TAYLOR (Liverpool)
Wolbachia host–symbiont interactions

E. FIRKRIG (New Haven, USA)
Human granulocytic ehrlichiosis

J. HINNESBUSCH (NIAID, USA)
Plague in fleas

P.W. ATKINSON (Riverside, USA)
Transgenic malaria

G. TARGETT (London SHTM)
Vaccines targeting vectors

● Other symposia and workshops

● Surface mediators
Cells & Cell Surfaces Group
Organizers: N.J. High & D.G.E. Smith

● Imported infections
Clinical Microbiology Group/ British Infection Society

● Virology and occupational health
Clinical Virology Group
Organizer: B. Cohen

● Tailor made or off the peg? Teaching and learning resources for microbiology
Education & Training Group
Organizers: M.R. Adams & H. Sears

● The role and impact of fungi on biogeochemical cycles
Environmental Microbiology and Eukaryotic Microbiology Groups/ British Mycological Society
Organizer: G.M. Gadd

● Protein production and purification
Fermentation & Bioprocessing Group
Organizers: M.G. Duchars & J. Miller

● Toxins in disease and therapy
Microbial Infection Group
Organizers: O. Sparagano & N. Fairweather

● RNA–protein interactions in micro-organisms
Physiology, Biochemistry & Molecular Genetics Group
Organizer: I. Stansfield

● Microbial diagnostics: applications and future prospects
Systematics & Evolution and Clinical Microbiology Groups

● Viruses and signalling (Symposium 1)
Virus Group
Organizers: W. Barclay & K.N. Leppard

● Viral hepatitis (Symposium 2)
Virus Group
Organizers: M. Harris, D.J. Rowlands & J. McLauchlan

● Workshops
Virus Group

Plant viruses (half day)
Organizers: S.A. MacFarlane (Scottish Crop Research Institute, Dundee) & J.P. Carr (University of Cambridge)

Retroviruses (half day)
Organizer: J.C. Neil (University of Glasgow)

DNA Viruses (1 day)
Organizers: S. Efstathiou (University of Cambridge) & M.A. Skinner (Institute for Animal Health, Compton)

RNA virus positive sense viruses (half day – a.m.)
Organizers: M.D. Ryan (University of St Andrews) & S.G. Siddell (University of Bristol)

RNA virus negative sense/ dsRNA viruses (half day – p.m.)
Organizers: W.S. Barclay (University of Reading) & P.E. Digard (University of Cambridge)

Human papillomaviruses
Organizer: S. Graham (University of Glasgow)

Deadline for the receipt of titles and abstracts: **28 November 2003**

Email addresses of all session organizers are available on the SGM website.

AUTUMN 2004 – 155th Meeting
Trinity College, Dublin
6–9 September 2004

● Main Symposium Novel anti-microbial therapies

Other proposed symposia include:

Lactic acid bacteria
Novel secretion
Antibiotic resistance
Microbial function
Epigenetic resistance
Gram-positive cell factories
Zoonotic infections
Molecular chaperones and protein folding

Irish Branch

Biocatalysis
UCD
4–5 September 2003
Organizer: Kevin O'Connor (kevin.oconnor@ucd.ie)

Invited speakers: D. BOYD (Queen's University Belfast), A. DOBSON (University College Cork), C. MURPHY (University College Dublin), F. HOEKS (Lonza AG, Switzerland), W. DUETZ (ETH Zurich) and C. KNOWLES (University of Oxford)

Food pathogenesis
National University of Ireland, Galway
Spring 2004
Organizer: Cyril Carroll

For details of Irish Branch activities contact the Convener, Catherine O'Reilly (coreilly@wit.ie)

Other News and Events

● Bioinformatics Workshops

Following the success of the workshops held jointly by the SGM and The Sanger Centre in 2002 the following further events will be held this year:

Bristol 29 August **Birmingham** 19 September

Registration fees (to include lunch, refreshments and set of literature):

Company staff	£100
Academics (university & research institute)	£50
Postgrads/first postdocs	£20*

**Grants are available – see website*

Attendance is restricted to SGM members only.

Many members were disappointed last year because the available places filled so quickly. Register now to ensure your attendance. Full details of the workshops and a booking form are available on the SGM website (www.sgm.ac.uk/meetings).

● SfAM/SGM One-day Regional Meetings

A joint initiative to sponsor one-day regional meetings in the UK and Ireland has been launched by the SGM and the Society for Applied Microbiology. See the website of either society for the full rules and to download an application form: **www.sfam.org.uk** or **www.sgm.ac.uk**

The next Regional Meeting will be:

Transport of microbes through soils

University of Lancaster
18 September 2003

A short overview of the topic will be followed by a mixture of invited and offered presentations. Posters will also be displayed. There will be a prize for the best oral presentation by a microbiologist in the early stages of their career. If you would like to participate, please contact the organizers: Keith Jones (k.jones@lancaster.ac.uk) or Kirk Semple (k.semple@lancaster.co.uk).

SchoolZone

MISAC 2003 Schools Competition

Your body is a fortress: a barrier to microbial invaders

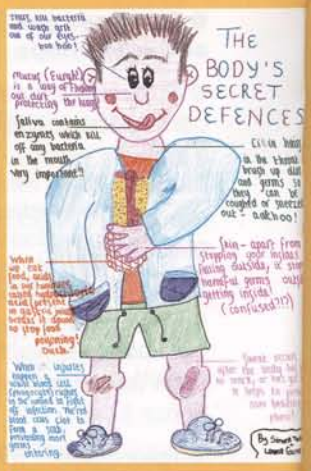
This year's secondary schools competition was sponsored by the SGM. It invited students to produce an eye-catching A3 annotated diagram of the human body highlighting non-specific barriers to infection by micro-organisms. The poster was required to serve as a visual aid to support a talk given to a peer group. Students needed to cover both physical barriers, e.g. skin and mucus and chemical barriers, e.g. gastric juices and lysozyme.

Once again the competition proved to be extremely popular, attracting over 1,000 entries and involving more than 1,600 students from 130 schools. There were two age groups, 11–14 and GCSE. Feedback from teachers shows that the competition's success is due to it being specification-led, allowing teachers to incorporate it into their lesson plans as either a piece of course work or an assessment opportunity.

A panel of microbiology education experts comprised of MISAC members and SGM staff, including SGM Executive Secretary Dr Ron Fraser, carried out the judging. They were overwhelmed, by not only the quantity, but also the high quality of the entries in both age groups and it was extremely difficult to select the winning entries. Adjudication took account of originality, scientific content and accuracy, presentation and the effectiveness of the poster as a means of communicating with the peer group. This year's competition lent itself to hand-produced entries and these featured heavily amongst the winners. However, it also gave opportunities for creative use of ICT skills.

The winner of the 11–14 age range was **Megan Clare** from St George's School, Ascot and the winner of the GCSE age range was **James Adair** from Newcastle Royal Grammar School.

Dr John Grainger, Chairman of MISAC, has already made presentations of cash prizes and certificates to both schools. In addition every school entering the competition received a pack of microbiology



ABOVE, RIGHT & BELOW:
11–14 age group winners. 1st prize (top left), Megan Clare, St George's School, Ascot; 2nd prize (top right), Simone Tambaros & Leanne Garner, South Hunsley School; 3rd prize (lower right), Nicola Read, Kirsty Read & Lauren Bibby, Howard of Effingham School; highly commended (right), Alicia Russell, Kirkham Grammar School.

LEFT:
GCSE group winners. 1st prize (top left), James Adair, Newcastle Royal Grammar School; 2nd prize (top right), Siobhan Wilde, Thornleigh Salesian College; 3rd prize (bottom left), David O'Sullivan, Brinsworth Comprehensive; highly commended (bottom right), Lauren Sparrow, Diss High School.

BOTTOM:
Judging day at SGM HQ. *From left to right:* Sue Assinder (SGM Education Officer elect), Muriel Rhodes-Roberts (SfAM), John Grainger (MISAC Chairman), Janet Hurst (SGM), John Tranter (CLEAPSS), Faye Jones (SGM), Ron Fraser (SGM), Peter Fry (MISAC Vice-Chairman).

Schools Membership costs only £10 a year. For this, a named teacher representative will receive *Microbiology Today* each quarter, advance notification and copies of new microbiology teaching resources, and discounted fees for attendance on SGM training courses and workshops. Application forms are available at **www.sgm.ac.uk**

Enquiries:
education@sgm.ac.uk

Website:
www.microbiology online.org.uk

SchoolZone

MISAC 2003 Schools Competition

Schools Membership costs only £10 a year. For this, a named teacher representative will receive *Microbiology Today* each quarter, advance notification and copies of new microbiology teaching resources, and discounted fees for attendance on SGM training courses and workshops. Application forms are available at **www.sgm.ac.uk**

Enquiries:
education@sgm.ac.uk

Website:
www.microbiology online.org.uk

Your body is a fortress: a barrier to microbial invaders

This year's secondary schools competition was sponsored by the SGM. It invited students to produce an eye-catching A3 annotated diagram of the human body highlighting non-specific barriers to infection by micro-organisms. The poster was required to serve as a visual aid to support a talk given to a peer group. Students needed to cover both physical barriers, e.g. skin and mucus and chemical barriers, e.g. gastric juices and lysozyme.

Once again the competition proved to be extremely popular, attracting over 1,000 entries and involving more than 1,600 students from 130 schools. There were two age groups, 11–14 and GCSE. Feedback from teachers shows that the competition's success is due to it being specification-led, allowing teachers to incorporate it into their lesson plans as either a piece of course work or an assessment opportunity.

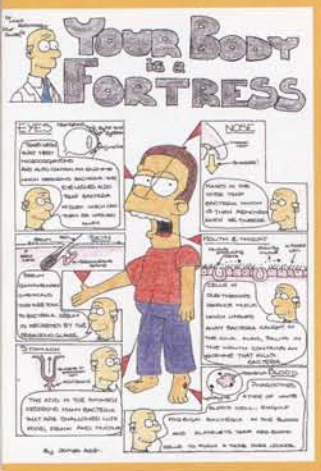
A panel of microbiology education experts comprised of MISAC members and SGM staff, including SGM Executive Secretary Dr Ron Fraser, carried out the judging. They were overwhelmed, by not only the quantity, but also the high quality of the entries in both age groups and it was extremely difficult to select the winning entries. Adjudication took account of originality, scientific content and accuracy, presentation and the effectiveness of the poster as a means of communicating with the peer group. This year's competition lent itself to hand-produced entries and these featured heavily amongst the winners. However, it also gave opportunities for creative use of ICT skills.

The winner of the 11–14 age range was **Megan Clare** from St George's School, Ascot and the winner of the GCSE age range was **James Adair** from Newcastle Royal Grammar School.

Dr John Grainger, Chairman of MISAC, has already made presentations of cash prizes and certificates to both schools. In addition every school entering the competition received a pack of microbiology

ABOVE, RIGHT & BELOW:
11–14 age group winners. 1st prize (top left), Megan Clare, St George's School, Ascot; 2nd prize (top right), Simone Tambaros & Leanne Garner, South Hunsley School; 3rd prize (lower right), Nicola Read, Kirsty Read & Lauren Bibby, Howard of Effingham School; highly commended (right), Alicia Russell, Kirkham Grammar School.

LEFT:
GCSE group winners. 1st prize (top left), James Adair, Newcastle Royal Grammar School; 2nd prize (top right), Siobhan Wilde, Thornleigh Salesian College; 3rd prize (bottom left), David O'Sullivan, Brinsworth Comprehensive; highly commended (bottom right), Lauren Sparrow, Diss High School.



BOTTOM:
Judging day at SGM HQ. *From left to right*: Sue Assinder (SGM Education Officer elect), Muriel Rhodes-Roberts (SfAM), John Grainger (MISAC Chairman), Janet Hurst (SGM), John Tranter (CLEAPSS), Faye Jones (SGM), Ron Fraser (SGM), Peter Fry (MISAC Vice-Chairman).

teaching resources and each student was sent a certificate of entry.

Further details of the winners are available on the SGM education website at **www.microbiologyonline.org.uk**. A selection of the posters will be on display at SGM's 153rd Meeting at UMIST, Manchester, from 8 to 11 September 2003 and also at the ASE annual meeting at University of Reading, from 8 to 10 January 2004 on the MISAC stand.

MISAC wishes to express its sincere thanks to the SGM for sponsoring the 15th competition.

Next year's competition, *Composting: not just a load of old rot but a way to save the planet*, sponsored by the Society for Applied Microbiology, asks pupils to create an illustrated information leaflet suitable for distribution by a local authority to the general public to encourage the use of composting as an important contribution to the recycling of waste materials. It is hoped that once again this competition will attract a large number of entries from both Key Stage 3 and GCSE students. A competition entry form can be downloaded from **www.microbiologyonline.org.uk**

Dariel Burdass, SGM Education Projects Administrator

New Resource

Tuberculosis – can the spread of this killer disease be halted?

This is the first in an exciting new series of factfiles on the theme of *Microbes and Disease*. Aimed at post-16 students, the 8-page A4 size resource looks at many aspects of a disease which, once thought to be conquered, is now making a big comeback in many parts of the world. Starting with a history of TB, which has been around since at least the Iron Age, before moving on to its modern epidemiology and descriptions of the causative bacteria and how the infection is spread, compiler Dariel Burdass (SGM Education Projects Administrator) then tackles the immune response to TB, diagnosis, prevention, control and treatment before concluding with some of the latest research and speculating what may lie in the future. Background information on topics such as cell-mediated immunity, the emergence of drug-resistant TB and the synergy between TB and HIV is also provided. The resource concludes with a list of Key Points, a glossary, a list of further reading and some useful websites. It is illustrated throughout with high quality colour photographs. The text was checked by two SGM members who are distinguished experts on TB.

Catherine MacMahon, a teacher at Our Lady's School, Dublin was delighted with this resource which she described as '*A fantastically readable and attractive factfile on TB*'.

Copies of the Tuberculosis factfile were distributed to all school members of SGM in May, but are freely available from the External Relations Office. Email **education@sgm.ac.uk** if you would like one or use the online order form at **www.microbiologyonline.org.uk**

Microbial Menu Items

In response to our request for microbial recipes in the last *SchoolZone*, two have been submitted, both for fermented drinks (sadly neither is for beer or wine!).

Ginger Beer

Libby Riley from Sutton Coldfield has sent us a recipe which can be downloaded from **www.microbiologyonline.org.uk**

Ginger beer originated in England, in the mid-1700s, where it became the favourite drink for over 150 years. The forerunners of ginger beer were mead and metheglin, which is mead flavoured with herbs or spices. Mead is a yeast-fermented honey and water drink and has been around for a very long time. Records show that the Celts were drinking it as long ago as 500 AD. It is reputed to be one of the oldest recorded fermented beverages. Ginger beer also uses yeast for fermentation and is sweetened with honey, molasses or cane sugar. The yeast converts the sugar into ethanol (alcohol) and carbon dioxide (gas). Other ingredients include fresh whole ginger although in Libby's recipe this has been replaced with ground ginger and lemons or lemon juice. The yeast is also said to add a special flavour to the beer, which is similar to that of home-baked bread.

In England and Canada, the popularity of ginger beer peaked in 1935. The USA had 300 breweries, Canada had over 1,000 and England had 3,000!

Kombucha Tea

Many thanks to Roy Moore, Editor of *The Mycologist*, who sent in an article called 'The Kombucha consortia of yeasts and bacteria' which appeared in that journal (2000, **14**, 166–170).

Kombucha is the name given to a jelly-like mix of yeasts and bacteria that is cultivated in a solution of tea and sugar. The yeasts and the bacteria in the culture, while not dependent on one another for survival as in a symbiotic relationship, do grow in close association, forming a microbial community. Acetic acid bacteria, in particular *Acetobacter xylinum*, excrete a special gelatinous adhesive consisting of extracellular polymeric substances that provide a matrix in which yeasts are embedded in distinct clusters. During the incubation period a rubbery microbial mat is formed on top of the culture, consisting of micro-organisms embedded in a mesh of cellulose fibres. The micro-organisms ferment the tea and sugar producing a wide range of organic acids, vitamins and enzymes that accumulate in the liquid medium. This variety of metabolites accounts for the claims that Kombucha is beneficial to human health and can be used to cure many conditions, including asthma, insomnia, skin disorders and herpes.

While the SGM is not advocating the preparation of Kombucha tea for human consumption, as the sharing of 'starter cultures' is not regulated and they might contain potentially harmful contaminants, it is a potentially interesting investigation for exploring microbial communities, subject to the usual safety constraints and preparation of a risk assessment.

For further information on Kombucha Tea see **helios.bto.ed.ac.uk/bto/microbes/biofilms.htm**

Dariel Burdass, SGM

Gradline

A job in... Bioinformatics

Jane Westwell, SGM Careers and Grants Administrator, is taking over as Gradline Editor. Gradline will continue to feature job profiles, but contributions on any topic relevant to microbiologists in the early stages of their career are also welcome. Contact **j.westwell@sgm.ac.uk**

Profile

Name David Studholme

Age 31

Present Occupation
Computer Biologist in the Informatics Department of the Wellcome Trust Sanger Institute, Hinxton, Cambridge, UK.

Previous Employment
I have spent several years since my PhD doing laboratory-based research into genetic regulation in bacteria

Education
PhD, Imperial College of Science, Technology and Medicine, London, *Metabolic engineering of thermophilic bacteria for enhanced bio-ethanol production*

BSc, Southampton University, *Applied Biology*

Q *What is bioinformatics?*

'In the broad sense, it is the application of computer technology to biological problems. Recently, one of the high profile areas has been management and analysis of vast quantities of data from genome sequencing projects and presenting the data in a way that is useful and accessible to biologists.'

Q *Why did you choose bioinformatics for your career?*

'I always enjoyed tinkering with computers as well as biology. In the last few years, I used bioinformatics in my microbiology research and found it was the most enjoyable and successful aspect of my work. It seemed like the natural next step, as well as an exciting new challenge, to move into this area. It also didn't escape my notice that the opportunities for career development looked a lot rosier in bioinformatics.'

Q *Do you work in a narrowly focused or multidisciplinary team?*

'Many of the team come from a biological research background, along with several computer scientists. The bioinformaticists here use a large and complex computer infrastructure and so are very dependent on IT specialists in systems support and web developers. We collaborate closely with colleagues at the European Bioinformatics Institute (EBI), and also at Hinxton, which adds an extra dimension.'

Q *The Sanger Institute is world famous – does this make it an exciting place to work?*

'Yes it is – there is quite a buzz when a new genome project is completed or a Nobel prize is awarded! Being surrounded by some of the best biologists and bioinformaticists is a great environment for learning a lot quickly. It is also very rewarding to contribute to resources such as the Pfam and InterPro databases, used via the web by thousands of scientists worldwide.'

Q *What qualities make a successful bioinformaticist?*

'Enjoyment of problem-solving is very helpful. Obviously, an enthusiasm for computers as well as biology is important and a bioinformaticist must be open to learning about new techniques and technologies. Ability to work as part of a team is paramount; many of the bioinfomatics websites and databases are the product of large numbers of individuals, with diverse expertise and experience, working interdependently.'

Q *Are there many career opportunities in this area of research?*

'This is a fast-growing area. Institutes like the Sanger and the EBI seem to be continually expanding. New bioinformatics centres are springing up in universities, and there is plenty of demand for suitable candidates in industry, although perhaps more so in the US than in Europe. There are also many opportunities in the important roles of curating, developing and maintaining databases, applications and webservers that provide tools and hypotheses for research.'

Further information about bioinformatics careers

- The Bioinformatics Organization (**www.bioinformatics.org**) is an international website providing free and open resources for bioinformatics research development and education. It includes a page of FAQs.
- The European Bioinformatics Institute (UK outstation of European Molecular Biology Laboratory) website (**www.ebi.ac.uk**) includes information about jobs, studentships and a visitors' programme for researchers and postgraduate students.
- The MRC Human Genome Mapping Project Resource Centre (**www.hgmp.mrc.ac.uk**) includes information about jobs, PhD studentships, courses and FAQs.
- The Wellcome Trust Sanger Centre website (**www.sanger.ac.uk**) features details of available PhD studentships, postdoctoral fellowships and faculty positions.
- The International Society for Computational Biology website (**www.iscb.org.uk**) features a newsletter, and information about bioinformatics events, jobs and opportunities.
- The *New Scientist* website careers pages (**www.newscientistjobs.com/graduate/cac/**) includes a review of career opportunities in bioinformatics with a link to current vacancies. Other links include a range of commercial companies.

Careers

Where does your future lie?

Life Science Careers 2003

Once again SGM is helping to organize these popular one-day careers conferences for life science undergraduate and postgraduate students. This year's events are being held at:

King's College London (1 November)

UMIST, Manchester (15 November)

University of Wales, Cardiff (29 November)

Each conference includes a range of talks on career choices and further training, plus a small exhibition by companies, organizations and higher education institutions. There is ample time in the refreshment breaks for discussion with the speakers and other experts. A CV review service is also available, by prior arrangement.

Cost: £10, to include refreshments and lunch

Details of each event and a booking form are available on the web at **www.bsf.ac.uk/careers**

All enquiries to Sai Pathmanathan, The Physiological Society, PO Box 11319, London WC1V 6YB (email spathmanathan@physoc.org; Tel. 020 7269 5727).

Sponsored by:
- *Science's NextWave*
- *Astrazeneca*
- *New Scientist*
- *Pfizer*

Successfully surviving your PhD

The Education and Training Group Session at the SGM Edinburgh meeting in April attracted a capacity audience of almost 200 postgraduate students all eager to pick up tips and hints on easing their way through their PhDs.

The morning kicked off with a talk by Professor Howard Green from the UK Council for Graduate Education (UKCGE). He reviewed changes that have occurred in postgraduate education during the past 10 years, highlighting the huge growth in student numbers. He also outlined a range of current and future initiatives designed to improve the PG student experience, including the development of a new code of practice that will incorporate a set of standards for academic rigour and supervision of projects and the administrative process within institutions.

Tim Brown from the National Postgraduate Council followed with a thought-provoking talk about the rights and responsibilities of PhD students. He included advice for research students on taking responsibility for their own research. If your institution is affiliated to the NPC you will be able to access this information (and more) on the NPC website (www.npc.org.uk).

Liz Sockett (University of Nottingham) gave a very entertaining talk on '*Managing your supervisor*' which was based on years of her own experience as PhD student, postdoc, then as a supervisor. This wry look at the trials and tribulations of the student–supervisor relationship certainly struck a chord with many of the audience and offered an insight into supervisors' research priorities and other commitments. She also included a set of handy hints to help get over those potentially sticky moments that almost every research student experiences.

Joanna Verran (Manchester Metropolitan University) presented findings from the 2002 survey of SGM Postgraduate Student Members. Over 190 students had responded to the survey and they reflected a wide background and range of experience. Less than half of the respondents are funded by a Research Council grant – this was also true of the Edinburgh delegates – with universities, industry and overseas governments providing significant funding. The majority of students work in research teams of 1–10 postdocs and postgrads. Research activities include research seminars, lab meetings and presentations for most students, whilst a third are members of a journal club. Almost all postgraduates undergo training in a variety of skills with most of it being delivered in the first year. About 75 % of respondents attend SGM meetings and other conferences; however, not all of these people were aware of the Society's grant schemes to support these activities. The talk finished on a positive note: most respondents enjoy reading *Microbiology Today* and over a third would be willing to contribute to Gradline – we eagerly await your ideas!

The final session, '*SGM and you*', was led by Hilary Lappin-Scott (University of Exeter). She outlined the many benefits that you can all enjoy as SGM Postgraduate Student Members. The message about grants certainly struck home judging by an unusual flurry of Postgraduate Student Conference Grant applications after the Edinburgh meeting and an upturn in President's Fund applications! An open forum followed Hilary's presentation. A panel of SGM Council Members and HQ staff fielded questions and suggestions from the audience. Topics discussed included career development activities; availability of funding to support non-Research Council funded students wanting to attend a UK Grad School and an SGM-hosted postgrad discussion list.

The ideas have been taken on board and we are acting on some of them already. The next Council meeting will consider a scheme to fund Grad School attendance and the External Relations Office is planning a dedicated event for postgraduate students at the SGM meeting in Bath next March. Watch this space...

Biocareers

www.biocareers.org.uk

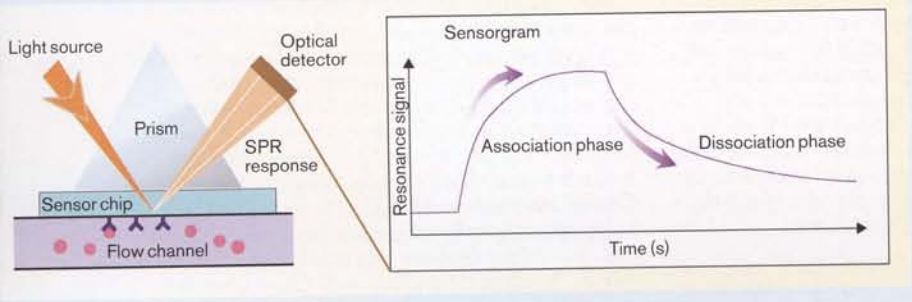
The SGM careers website is under continual development. Recently a range of Job Profiles has been added, based on those published in past issues of *Microbiology Today*. The website aims to provide information on training and opportunities for microbiologists at all stages of their careers. Topics featured include: funding; postdoctoral work; posts outside the laboratory; successful job hunting; notices of careers events and much more. SGM careers publications can be ordered on-line and individual questions will be answered if you email **careers@sgm.ac.uk**

International Research Fellowship report

Analysis of biomolecular interactions between plant-virus-encoded and host proteins, and viral particles and proteins by surface plasmon resonance

N. Kalinina

Being a plant virologist and dealing with the molecular biology of viruses, and mainly with the biochemical properties of movement proteins (MP), I have never used physical methods in my research. The SGM fellowship gave me an excellent opportunity to investigate interactions between proteins using surface plasmon resonance (SPR) detection with the BIAcore instrument at the world renowned Scottish Crop Research Institute, Invergowrie, Dundee. I arrived at Edinburgh airport on 5 August 2002 from Moscow, Russia, and was given a warm welcome by Dr Lesley Torrance, who drove me to Dundee and introduced me to other lab personnel.



ABOVE:
Fig. 1. Principle of interaction analysis by an SPR biosensor.

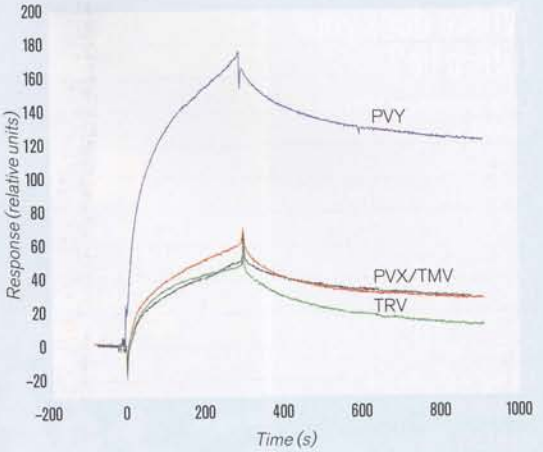
TOP RIGHT:
Fig. 2. Sensorgram showing binding of virus particles to pectin methyl esterase (PME) immobilized on a sensor chip.

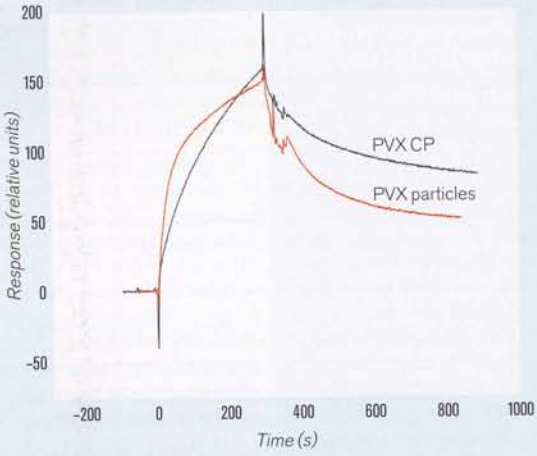
LOWER RIGHT:
Fig. 3. Sensorgram showing binding of Potato Virus X capsid protein (CP) or particles to p25 immobilized on a sensor chip.

COURTESY N. KALININA

SPR-based biosensors monitor non-covalent interactions over time between biological macromolecules, proteins, RNA or DNA. This approach means that qualitative and quantitative (kinetic rate constants) data can be obtained for the association and dissociation of macromolecular complexes. Usually, one reactant is immobilized on the sensor surface, which forms part of the flow cell at the opto-interface (Fig. 1) and the other reactant(s) in solution are injected into the flow cell where they pass over the surface. As the molecules interact the changes in refractive index at the surface are detected and displayed in a sensorgram. An advantage of this approach is that the association and dissociation rate constants and binding affinity can be obtained, providing an insight into the mechanisms of complex formation under a range of experimental conditions. SPR analysis is therefore complementary to other biochemical and biophysical methods that help us to understand macromolecular interactions and their function in biological systems.

The purpose of my study was to try to estimate interactions between viral and cellular proteins in kinetic terms using SPR. Nobody has studied these interactions in our area using this method. It is known that during the cycle of viral infection there are numerous interactions between different proteins





encoded by viral genomic RNA and viral and cellular proteins, and between viral and cellular proteins and virions. These physical interactions possibly have important functions in maintaining normal infection in plant cells and in propagating the virus in the plant. In Moscow, we have used different genetic and biochemical approaches to investigate mechanisms of virus movement in plants. In the present study I applied SPR analysis to estimate these interactions quantitatively. Kinetic analysis of protein binding (viral and cellular) is interesting from both biological and mechanistic points of view and might be extremely useful in understanding the mechanisms of the different processes.

In preliminary experiments I was interested in qualitative data. I immobilized to the dextran surface of CM5 and B1 sensor chips three different recombinant proteins: 25 kDa MP of Potato Virus X (PVX); 30 kDa MP Tobacco mosaic virus (TMV) and the cellular protein pectin methyl esterase (PME), a cell-wall protein that has been found to interact with the TMV 30 kDa MP. I tested their interactions with different viral MPs, their mutants and various virus particles [PVX, TMV, Tobacco rattle virus (TRV), Potato Virus Y (PVY)]. We found that the SPR method was suitable for demonstrating interactions between many of these and some examples are given below.

The cellular protein-receptor PME was immobilized to a B1 sensor chip, using the amino coupling procedure. We investigated PME binding to Cucumber Mosaic Virus (CMV) MP 3a and its mutant MP. The comparative study showed that binding properties of these proteins differ and the deletion mutant dissociated more slowly from PME. We think that these results might reflect the different biological and biochemical properties of these proteins. From the tests on virus particles only PVY strongly interacted with PME; other particles, including PVX, TMV and TRV, interacted weakly at the same concentrations (Fig. 2). This may be important in the pathways of virus infection.

Then I compared interactions between PVX particles and recombinant PVX coat protein (CPR) with the 25 kDa MP encoded by the first gene of the PVX triple transport gene block. It was shown previously by the Moscow team that 25 kDa MP interacted with PVX virions and made them translatable *in vitro*. Moreover, the 25 kDa MP interacts only with one end of the virus particle. The 25 kDa MP was immobilized to the dextran surface of a CM5 sensor chip. We found clear differences in the rates of dissociation of the PVX particles and CPR: CPR dissociated about 3–5 times slower than native particles (Fig. 3). These differences also must be related to structural (conformation) differences between the CP in the virion and soluble non-modified CPR. Then a mutant of the 25 kDa MP without an N terminus was immobilized to the CM5 chip instead of the full-size 25 kDa MP; again we found differences in the shapes of the curves and in the rates of association and dissociation of the PVX particles. A CPR mutant of 25 kDa without a C terminus, which does not bind PVX particles *in vitro*, had the same properties using SPR analyses. In control experiments neither TMV particles nor TRV particles bound immobilized PVX 25 kDa MP. Therefore, our preliminary kinetics results support our biochemical data. In our opinion these nano-technology investigations are very useful and provide a new perspective on processes in the infected cell.

I enjoyed my stay in Dundee and I was happy to work at the SCRI. I am very grateful to Drs L.Torrance and M. Taliansky who made my visit possible and helped me during all my work. I am also grateful to all my colleagues for the warm and friendly atmosphere, the SGM for their financial support and personally Dr Jane Westwell for her efforts in making my work and my stay in the UK comfortable and unforgettable.

● ***Dr N. Kalinina is a Senior Scientist in the Virology Department, A.N. Belozersky Institute of Physico-Chemical Biology, Moscow State University, Russia.***

Microbiology in the Regions report

Peninsula Microbiology Forum Meeting (17 March 2003)

■ Rachel Legg

As part of a new initiative to promote microbiology in the UK at a regional level, SGM and SfAM co-sponsored the recent meeting of the Peninsula Microbiology Forum at the Marine Biological Association (MBA), Plymouth. The Forum was set up to promote increased co-operation amongst microbiologists in the south west of England. It also aims to give young scientists the opportunity to present their work to senior colleagues.

Over 40 members from a variety of microbiological backgrounds heard the invited speakers. Professor Nick Mann (University of Warwick) described his discovery of viruses containing photosynthetic genes and Dr Marina Morgan (Royal Devon and Exeter Hospital) opened the audience's eyes with a pictorial and verbal account of the life of a hospital consultant. Following lunch and poster viewing, the final guest speaker, Dr Miguel Camara (University of Nottingham), gave a clear overview of quorum sensing.

Throughout the day postgraduate students gave presentations on topics as diverse as the rapid detection of bacterial spores, determining hydrological pathways of pathogen transfer from grassland soils to surface waters, pandas and oil cutting degrading halophiles. These were judged by the guest speakers for the SGM/SfAM award for the best paper by a microbiologist in the early stages of their career.

After a final discussion session, a very enjoyable meeting ended with Alan Vivian (General Secretary, SGM) presenting the Microbiology Communication Prize of £150 cash and a certificate on behalf of both societies. He commented on the judges' difficulties in selecting a winner, due to the high standard of all the talks. The award went to Matt Hall from the Marine Biological Association, Plymouth.

The forum would like to thank SGM, SfAM, Bio-Rad and Thermo Life Sciences for sponsoring this event.

For further information on SGM/SfAM Joint Regional Meeting grants, see **www.sgm.ac.uk** or **www.sfam.org.uk**

● ***Rachel Legg is a postgraduate student at the University of Exeter.***

TOP:
The MBA, Citadel Hill, Plymouth.

MIDDLE:
From left to right: Apprehensive postgraduate presenters James Ascott (Exeter), Matt Hall (MBA, Plymouth), Tracey Love (Plymouth/CBD), Viv Collins (Plymouth/DSTL) and David Oliver (IGER).

BOTTOM:
Matt Hall of the Marine Biological Association receiving the SGM/SfAM award from Alan Vivian for his presentation on *Synechococcus and Cyanophaga diversity during a mesocosm experiment.*

PHOTOS COURTESY GILL CAIRNS, UNIVERSITY OF EXETER

Hot off the Press

Microbiology Today Editor Meriel Jones takes a look at some papers in current issues of the Society's journals which highlight new and exciting developments in microbiological research.

PHOTO: DIGITALVISION

Arming the enemy

Antibiotics were the wonder drugs of 20th century medicine, curing infections that had previously been lethal. Unfortunately, no-one realized that bacteria would evolve such effective resistance to them so quickly. Only the development of new antibiotics prevents medicine returning to a pre-antibiotic era, and new ones are not easy to find. One brand new class of compounds that shows great promise are cationic antimicrobial peptides. Some are starting to enter clinical use. However, two researchers wonder if we are going to encounter a unique threat to public health when resistance to these new antimicrobial treatments arises.

Graham Bell and Pierre-Henri Gouyon, from McGill University in Canada and the Université Paris-Sud in France, are concerned about ribosomally synthesized antimicrobial peptides (RAMPs). These are made in the same way as proteins by every kind of organism, including humans. They are incredibly diverse and have been protecting us from bacterial infection for millions of years. They stick to the bacterial cell membrane because it is negatively charged and actually kill the cell by making holes in the membrane. The membranes of animals, plants and fungi have virtually no charge and are therefore intrinsically immune to RAMPs. Some researchers argue that because this charge is an essential feature of bacterial physiology, it will be impossible for resistance to RAMPs to arise.

People discounted the idea of resistance to antibiotics at first because they knew that mutations conferring resistance would be very rare. What they did not appreciate was both the ability of bacteria to transmit resistance between cells, and even species, and also the effectiveness of natural selection. Bell and Gouyon have searched the scientific literature and found many reports of resistance to RAMPs. One example is among the genus *Salmonella*, the agents of typhoid and food poisoning. Switching on a series of systems to resist the RAMPs of their human victims has turned out to be a normal part of their pathogenic strategy.

Evolution of resistance to any antimicrobial compound depends on mutations arising within the bacteria that confer resistance. In theory there are several ways in which bacteria could resist RAMPs, and researchers have used carefully designed experiments to show how these could occur in practice. Resistance to RAMPs comes at a cost, and the growth rate of resistant bacteria is frequently slower than normal, sensitive bacteria. This means that they would usually be at a disadvantage, and may tend to vanish from bacterial populations. The only time they would have an advantage is when the RAMP is present. Then they would live, and the normal bacteria would die. Researchers can use mathematical equations to simulate this process. Since RAMPs are part of our normal armoury against infection, some bacteria have always been exposed to them. However, prescribing RAMPs for an infection would increase the extent and length of the exposure. Computer simulations show that this might allow many more types of resistant mutants to invade a host and persist in the population. Although simulations are not the same as real life, the wide range of presumptions that might allow bacteria to evolve resistance to RAMPs worried the researchers.

The danger of bacteria developing resistance to RAMPs arises from the fact that humans, and many of our farm animals and crops, are producers of these natural antimicrobials. If bacteria are allowed to develop new ways of evading our normal defences against disease, the consequences may be far worse than simply returning to a pre-antibiotic era. Minor cuts and scrapes might not heal properly and would allow bacteria to enter and spread throughout the body. The ability of the passive immune system to deal with infections would be reduced, making recovery slower, and many diseases more lethal. When antibiotics were discovered, scientists knew nothing about how bacterial resistance would develop, but now, after half a century's experience, we know just how serious the problem is. Before RAMPs enter routine clinical practice, Bell and Gouyon are convinced that we ought to guard against the potential rise of resistance to them much more carefully.

Bell, G. & Gouyon, P.-H. (2003). Arming the enemy: the evolution of resistance to self-proteins. *Microbiology* 149, 1367–1375.

Importing cervical cancer

Epidemiology shows a link between human papillomavirus (HPV) and many cases of cervical cancer. However, it cannot explain how the virus causes cancer because that depends on exactly what it gets up to within human cells. Viruses contain the genetic instructions for duplicating themselves, but rely on their host's cells to do everything. Most infections with HPV do not lead to cancer, so the reason why some of them do is particularly intriguing.

Scientists have already discovered that one viral protein, called E6, encourages the destruction of a human protein that normally suppresses the development of tumours. However, there are suspicions that E6 can do other things as well. French researchers, led by Murielle Masson from the Ecole Supérieure de Biotechnologie de Strasbourg in France, have been checking exactly where E6 gets to within the cell. They developed a very specific way to detect E6 by using antibodies, and then spent time making their assay as sensitive as possible. When they examined human cell lines that had been deliberately encouraged to make lots of the E6 protein, the researchers had no trouble detecting it, but only their most sensitive experiments could detect E6 in cells with natural, low, levels of the protein. However, the E6 protein was always predominantly in the nucleus, and particularly in regions where genes were in use, rather than other areas of the cell.

This location fitted with the idea that E6 can interact with the proteins that normally control gene expression, but opened up the question of how it got into the nucleus. Proteins are assembled in the cytoplasm of cells. The nucleus is surrounded by a membrane that allows small proteins to drift into it, but large ones have to be

deliberately escorted inside. E6 is sufficiently small that it could just about slip inside unaided, but to check, the researchers attached it to another, much larger, protein that usually stays in the cytoplasm. When they tested the location of this new hybrid protein, it was in the nucleus, indicating that E6 contains signals to ensure it is always imported into the nucleus. As a result of these experiments the researchers are certain that they are well on the way to discovering the full list of E6's multiple abilities.

Masson, M., Hindelang, C., Sibler, A.-P., Schwalbach, G., Travé, G. & Weiss, E. (2003). Preferential nuclear localization of human papillomavirus type 16 E6 oncoprotein in cervical carcinoma cells. *J Gen Virol* **84**, 2099–2104.

Time trends in cervical cancer

Human papillomavirus (HPV) has been identified as a major cause of cervical cancer. The virus is spread by close personal contact, particularly during sex. However, most infected women do not develop cancer, and even if the disease does develop it can be one or two decades after infection before any symptoms appear. As an added complexity, there are over 30 types of HPV. One of these, type 16, has been more closely linked to later development of cervical cancer than others, such as types 6 and 11. There are also some women who develop the cancer without having been infected by HPV. To predict future trends in cervical cancer, it is therefore important to know about past infections with HPV within the community.

In Finland, screening programmes have reduced the incidence of some types of cervical cancer, but against a background of a rising number of incidences, particularly among young women. Researchers in the Finnish Cancer Registry and National Public Health Institute have used a national resource to investigate the incidence and prevalence of infection with HPV-6, -11 and -16 in Finnish women from 1983 to 1997. They hoped to discover whether epidemics of HPV-16 preceded the increases that they have seen in cervical cancer during the 1980s and 1990s. They were able to use the serum bank from the Finnish Maternity Cohort. This is blood serum generously donated by 96 % of all pregnant Finnish women, partly to screen for infections that would affect the health of themselves or their babies, but also as a national resource for clinical research. These women have, of course, had sex, and thus been at risk of exposure to HPV. The researchers checked for the presence of antibodies to three strains of HPV in serum samples from 7,862 women who had become pregnant twice within 5 years. If the second sample, but not the first, had antibodies to HPV, it indicated that the woman had been exposed to the virus between her pregnancies.

Their tests showed that there had been a steady increase in the incidence of HPV-16 infection from 1983 to 1997 in women who had had at least two pregnancies between the age of 24 and 32, and this predated the increased incidence of cervical cancer. In younger women, who had had two pregnancies before they were 24, the incidence of HPV-16 was fivefold higher. In contrast, the prevalence of the HPV-6 and -11 strains had not increased, implying that their transmission from person to person is different from that of HPV-16.

The results make it very clear that there has been an increase in the background exposure to HPV-16 in Finland before an increase in cervical cancer, which is important information for developing national policy about both HPV vaccination and cancer screening.

Laukkanen, P., Koskela, P., Pukkala, E., Dillner, J., Läärä, E., Knekt, P. & Lehtinen, M. (2003). Time trends in incidence and prevalence of human papillomavirus type 6, 11 and 16 infections in Finland. *J Gen Virol* **84**, 2105–2109.

When is an outbreak not an outbreak?

In a recent issue of the *Journal of Medical Microbiology*, Philip P. Mortimer from the Central Public Health Laboratory in London proposed a series of criteria to identify an outbreak of an infectious disease. Detecting that there has been a sudden increase in the rate of transmission of an infectious agent, the formal definition of an outbreak, is not that easy. People may be ill, or simply infected with the microbe without showing any symptoms. The increasing human population, air travel, intensive farming, innovations in food preparation and novel medical treatments all give new and rapid ways for microbes to spread. The emergence of new pathogens adds to the need for good ways to recognize outbreaks and intervene to bring them to an end.

Fortunately, pathogenic micro-organisms can now be characterized much more easily and accurately than ever before, so that outbreaks that might have been missed in the past can be recognized and treated. In the UK, continuous low-profile surveillance is the key to preventing and controlling outbreaks. The Communicable Disease Surveillance Centres and the Scottish Centre for Infection and Environmental Health in the UK, along with similar organizations in other European countries can quench outbreaks before the public has even become aware of a problem, provided someone spots the first crucial signs. There has to be some sort of pattern to all the cases, giving them a timing or place in common. There can frequently be a common source of infection, so that all cases turn out to have eaten a particular food, or shared a holiday destination. Identifying someone who is unaffected and who did not eat a particular food, or was absent at a critical time can be a valuable way of confirming the source.

It is essential to check that the same micro-organism is associated with all the cases. It may be easy to identify which species is involved, but much more difficult to pin down the exact strain. Fortunately, microbiologists have been building up information on the best ways to distinguish between individuals within a microbial species. If patients have recovered from the infection, the only way of testing for the causal organism may be to check whether their immune system has produced antibodies to it, and these may not distinguish between strains.

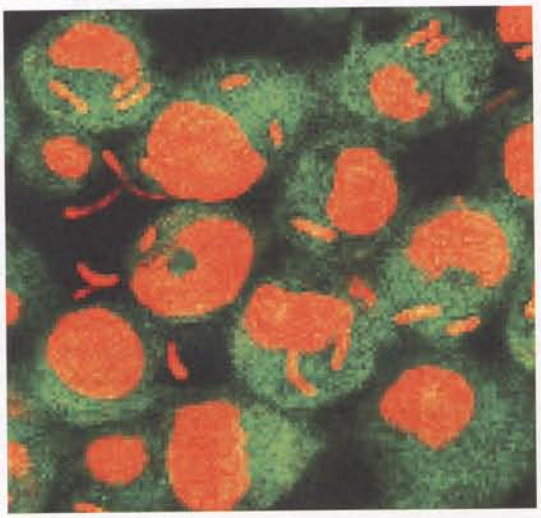
The final confirmation that an outbreak has been successfully contained is when the outbreak ends, with no further reports of cases. It implies that identification of the source, route of spread, method of treatment and of the organism were all successful. Continuous surveillance, rapid and accurate identification of microbial strains, and focused measures to eradicate sources of communicable diseases all play their part in the important objective of resolving outbreaks as quickly as possible. This applies as much to human disease, for example SARS, as it does to animal disease such as foot-and-mouth.

Mortimer, P. P. (2003). Five postulates for resolving outbreaks of infectious disease. *J Med Microbiol* **52**, 447–451.

RIGHT:
Laser confocal microscopy image of macrophages infected with *C. perfringens*. The cytoplasm of the macrophages was stained with CellTracker Green and the bacterial and macrophage nuclei were stained with propidium iodide (red).
COURTESY DAVID O'BRIEN, VIRGINIA TECH, BLACKSBURG, VA, USA

OPPOSITE PAGE:
The cypovirus endoparasitoid wasp *Diadromus pulchellus* and its host, the pupa of the leek-moth, *Acrolepiopsis assectella*.
COURTESY FABRICE BÉNÉDET

Gangrene – evading the body's defences



Clostridium perfringens is the infamous bacterium that causes gas gangrene. It requires an oxygen-free environment, and normally lives innocuously in places such as soil and the large intestine of humans. However, when it gets into areas of the body that lack oxygen, the symptoms of gangrene can be apparent within 6 hours. Deep wounds, or blockages in the blood circulation, are the usual culprits, and once the infection starts it rapidly spreads to healthy tissue and is always fatal if left untreated. The reason is the mixture of toxins that the bacterium releases into the bloodstream, causing cardiac stress and severe shock to the whole body.

David O'Brien and Stephen Melville of Virginia Tech in the USA have discovered that, intriguingly, *C. perfringens* cells can persist within some macrophages even under aerobic conditions. Macrophages are cells of the immune system that detect, engulf and then destroy invading micro-organisms. O'Brien and Melville wanted to know how these bacterial cells managed to survive. They knew that the way that bacteria get into macrophages is an important influence on how effectively they are killed. The surface of macrophages is covered with several types of receptors that pick out pathogens by the molecules on their surface. The interaction of the receptor is the start of the process of phagocytosis, which is supposed to end in the destruction of the bacterial cell. Depending on which receptor recognizes an invader, the pathogen may be simply taken into the macrophage, or can be doused with toxic chemicals as well.

The researchers have now discovered that three receptors are involved in the phagocytosis of *C. perfringens*. They are the scavenger, mannose and complement (CR3) receptors. They recorded how many bacteria they could find within a tissue culture line of mouse macrophages after incubating the cells with bacteria. To identify which receptor was involved, they looked for a difference after adding chemicals that block the activity of each class of receptor. To clinch the role of the scavenger receptor they repeated their measurements using transgenic Chinese hamster cells that produced the mouse scavenger receptor. *C. perfringens* rarely entered non-transgenic Chinese hamster cells, but readily became attached once the hamster cells had the mouse scavenger receptor.

A lot of information about what a receptor looks for on the surface of a bacterial cell is already known. For the mannose receptor it is the carbohydrate mannose and for the scavenger receptor it is the negative charge conferred on carbohydrate polymers by glucuronic acid. These are found in a surface coating, the capsule, on other *C. perfringens* strains, but this was not supposed to be present in the strain that the American group were using. However, their electron microscope pictures showed that the macrophages attached to fibres on the bacterial surface, which turned out to be made from exactly the right sugars. It looks as if this strain of *C. perfringens* actually encourages macrophages to engulf them, because once inside they have a ready source of nutrients and some protection from oxygen.

O'Brien, D. K. & Melville, S. B. (2003). Multiple effects on *Clostridium perfringens* binding, uptake and trafficking to lysosomes by inhibitors of macrophage phagocytosis receptors. *Microbiology* 149, 1377–1386.

Keratin-digesting bacterium

Collaboration between researchers at Kuwait University and the Deutsche Sammlung von Mikroorganismen und Zellkulturen in Braunschweig, Germany, has revealed a new species of bacteria with an unusual ability. *Amycolatopsis keratiniphila* can digest keratin. This protein is the major component of wool, feathers, hair and horn. A moment's thought about how long these can stay in good condition indicates how very few micro-organisms have the trick of degrading keratin.

The scientists isolated these bacteria from marsh soil in Kuwait by providing sterile, degreased wool as the sole source of nutrition. The cells grew as a light-grey meshwork that instantly fitted the characteristics of the bacterial grouping called the actinomycetes, but it took extensive research into their chemical and DNA composition to name the species with confidence. In fact, although the characteristics fitted into the genus *Amycolatopsis*, they were sufficiently different from all of the others to merit being named as a new species, *A. keratiniphila*, after its unusual ability.

Al-Musallam, A. A., Al-Zarban, S. S., Fasasi, Y. A., Kroppenstedt, R. M. & Stackebrandt, E. (2003). *Amycolatopsis keratiniphila* sp. nov., a novel ketatinolytic soil actinomycete from Kuwait. *Int J Syst Evol Microbiol* 53, 871–874.

Micro Shorts

Parasitic wasp has new stealth agent

Insects, like other animals, suffer from virus infections. A group of French researchers has recently explained how one wasp uses several viruses to boost its parasitic success. Although the moth *Acrolepiopsis assectella*, otherwise known as the leek-moth, is a predator of leek plants, it is, in turn, preyed on by a wasp. This solitary wasp, *Diadromus pulchellus*, uses the moth pupae as the host for its young, but has to overcome the immune system of the leek-moth to ensure success. One common strategy of parasitoid wasps is to exploit a virus to interfere with their host's immune system. They infect the host with the virus at the same time as injecting each egg, and then the viral gene products interfere with the host's defence mechanisms and development. Until recently, all *D. pulchellus* that had been tested in France were infected by two types of virus, an orthoreovirus called DpRV-1 and the ascovirus DpAV-4, both of which could interfere with the moth's immune response.

However, in 1999 the French group found a wasp on a leek field near Tours that was free of both DpRV-1 and DpAV-4, but still extremely effective at parasitizing leek-moths. Since the researchers had earlier discovered that the wasp eggs never hatched if they were implanted without a virus, they began a search for other viruses. A combination of electron microscopy, to look at the appearance of virus particles and their location within the insects, and nucleic acid analysis, led them to identify a new cypovirus. The virus, which they named DpRV-2, was present in the female genitalia of the wasps, and was injected into the moth pupae along with an egg. In the moth, the virus developed in the gut cells, while the wasp larvae grew in the moth's abdominal cavity. After 4 days the wasp larvae had filled the whole of the abdomen of the moth pupa and killed it, which also halted the viral infection which had spread throughout the parasitized pupa. When the scientists injected the virus alone into the moth, it quickly spread, killing the moth.

The researchers wanted to confirm that DpRV-2 could affect the moth's immune response, so they carried out a series of experiments that involved inserting nylon monofilaments into moth pupae. The majority of non-parasitized pupae reacted to the filaments by creating a capsule and melanized layer to surround and isolate them. This was precisely what the researchers had seen happen to wasp eggs within the moth if they had not been inserted along with a virus. Once the pupae were parasitized, many fewer of them reacted to the nylon threads. Infection with the DpRV-2 virus alone had no effect on encapsulation, but did reduce the rate of melanization substantially. The overall picture is of a wasp and a series of viruses that combine to exploit a moth for their mutual benefit.

Renault, S., Bigot, S., Lemesle, M., Sizaret, P.-Y. & Bigot, Y. (2003). The cypovirus *Diadromus pulchellus* RV-2 is sporadically associated with the endoparasitoid wasp *D. pulchellus* and modulates the defence mechanisms of pupae of the parasitized leek-moth, *Acrolepiopsis assectella*. *J Gen Virol* **84**, 1799–1807.

EDUCATION

LTSN

The *Bioscience Education Electronic Journal* (BEE-J), published bi-annually by the LTSN Centre for Bioscience, is now online (**http://bio.ltsn.ac.uk/journal/**). It publishes articles on tertiary level bioscience education, including peer-reviewed research and practice papers, descriptive articles and reviews, of interest to tertiary level staff and students and upper secondary school staff. Contributions to the journal are welcome. Instructions to authors are posted on the website. The LTSN Bioscience ImageBank pilot is now also open (**http://ltsn.ac.uk/imagebank**). It includes images contributed by the bioscience community which are freely downloadable, with rights cleared for educational use. Contributions to the ImageBank are welcome.
The proposed merger of the LTSN with the Institute for Learning and Teaching in Higher Education and the Higher Education Staff Development Agency to form an Academy for the Advancement of Learning and Teaching is up for consultation. The role of the Academy would include support to enhance learning and teaching at tertiary level. The LTSN Centre for Bioscience hopes to maintain its existing services within the new framework.

UK GRAD Programme

GRADschools are 3, 4 or 5-day residential courses designed for postgraduate research students to assess their personal skills, and develop team-building and career management skills. The courses are free to all second and third year students funded by the Research Councils, AHRB, Wellcome Trust and Royal Society of Chemistry. To check availability of courses, book a place, and make use of the 'just for postgrads' section on the website, please visit **www.grad.ac.uk**. For more information email **admin@grad.ac.uk** or telephone **01223 448510**.

UK GOVERNMENT

A Strategy for Women in Science, Engineering and Technology

The Promoting SET for Women Unit has announced a new integrated approach to tackling the problem of the under-representation of women in science, engineering and technology (SET) in employment, education and policy making in the UK. This is outlined in *A Strategy for Women in Science, Engineering and Technology*, which is available from the **www.set4women.gov.uk/set4women/research/the_greenfield_response.htm**. The new strategy is the Government's reply to the Greenfield report, *SET Fair*, which reviewed the current status of women's participation in SET and was published in November 2002.

Of little benefit?

The Government has launched a new independent study to examine in detail the benefits and risks of nanotechnology. Working with materials on the nanoscale – 80,000 times smaller than the width of a human hair – nanotechnology has the potential to improve our health and wealth, but it is important that any necessary regulatory framework is in place early on (see **www.ost.gov.uk/policy/issues**).

Food Standards Agency new chief executive

Dr Jon Bell has been appointed as the Agency's new Chief Executive. Dr Bell has been the acting Chief Executive since December 2002 and was previously Deputy Chief Executive and Director of Food Safety.

Chicken feed

The FSA has launched a consultation on its strategy to tackle the problem of *Campylobacter* in UK-produced chicken. *Campylobacter* is a common cause of food-borne illness in Britain. The deadline for receipt of comments is **8 September 2003**. SGM will be submitting a response (**www.food.gov.uk**).

Foot-and-mouth disease

European Agriculture Ministers have agreed a proposal for EU-wide measures on the control of foot-and-mouth disease, including the requirement for Member States to have arrangements in place for possible use of emergency vaccination as soon as the disease is confirmed. The proposed Directive was welcomed by UK officials, who stressed that Defra had played a pivotal role in shaping it, calling on their experience during the UK outbreak in 2001 (**www.defra.gov.uk**). Defra have launched an online database of the 2001 foot-and-mouth disease outbreak. It contains all the statistics compiled at the time and will be a unique reference tool for scientists studying and modelling control options for future animal disease outbreaks (**http://footandmouth.csl.gov.uk**).

Reviews

If you would like your name to be added to our database of book reviewers, please complete the book reviewer interests form now available on the SGM website.

A classified compendium of book reviews from 1996 to the present is also available on the website.

A list of publisher's website addesses is given on p. 144.

Molecular Biology of Picornaviruses

Edited by B.L. Semler & E. Wimmer
Published by American Society for Microbiology (2002)
US$189.95, pp. 546
ISBN: 1-55581-210-4

With 39 chapters spanning the history, molecular and cellular biology, and pathogenesis of picornaviruses, and the involvement of over 100 contributors, this near 500-page tome is certainly comprehensive. It provides a timely insight into our understanding of these viruses shortly before poliovirus becomes only the second infection to be eradicated by vaccination. The book is well laid out with each major section having an introductory overview, prior to detailed chapters on specifics. Some of these are already out-of-date, and they contain varying amounts of unpublished information. However, it is unfair to criticize the minutiae of such a diverse and, in places, rapidly moving field. This book represents the best review of this group of human pathogens in the last 15 years, and as such is highly recommended to students of related fields, libraries, or other parties who need a single-source snapshot of picornavirus research in the year 2000.

■ ***David Evans***
Institute of Virology, University of Glasgow

Japanese Encephalitis and West Nile Viruses. Current Topics in Microbiology and Immunology, Vol. 267

Edited by J.S. Mackenzie, A.D.T. Barrett & V. Deubel
Published by Springer (2002)
Euro129.00/SFr 208.50/£90.50/US$129.00, pp. 416
ISBN: 3-540-42783-X

The flaviviruses, Japanese encephalitis (JEV) and West Nile (WNV), are two of the most important emerging diseases of humans, together posing a threat to much of the world's population. The current volume provides a detailed and comprehensive account of many aspects of the biology of these fascinating viruses, from ecology to pathology, with chapters written by some of the leading workers in the field. Most impressive is that this book beautifully illustrates how the epidemiology of these viruses depends so critically on ecological context – the specific geographic regions where JEV and WNV are found and how they interact with other viruses in the population. Consequently, the reader will learn a great deal about flaviviruses in general. Although the book is necessarily a little repetitive, it constitutes a timely and essential resource for those working with JEV and WNV, and a valuable case study for anyone interested in viral emergence.

■ ***Eddie Holmes***
Department of Zoology, University of Oxford

Soil Ciliates (Protozoa, Ciliophora) from Namibia (Southwest Africa), with Emphasis on Two Contrasting Environments, the Etosha Region and the Namib Desert. Part I: Text and Line Drawings. Part II: Photographs. Denisia 5

By W. Foissner, S. Agatha & H. Berger
Published by Denisia, Museum of Upper Austria (2002)
Euro150.00
Vol. 1, pp. 1,063; Vol. 2, pp. 1,459
ISSN: 1608-8700

Willie Foissner is a remarkable man. He has championed the field of soil protozoology, describing countless new taxa and in this work turns his attention to the dry and hostile environment of Namibia. You might reasonably expect there to be comparatively few ciliates: Foissner shows us in this lavishly illustrated book just how wrong you would be. From 73 samples, collected whilst on holiday in 1994 (and what did you bring back from your last holiday?) he describes 365 species, 128 of which are new to science. Notwithstanding that 'everything is everywhere', the community structure in Namibia is, perhaps unsurprisingly, atypical. Undersampling, Foissner argues, is what really limits our understanding of diversity. The production and quality of the images lives up to Foissner's very high standards. The work is breathtaking and given its size and quality, remarkably good value. A must-have for anyone interested in soil, microbial diversity or ciliates.

■ ***Dave Roberts***
The Natural History Museum, London

Borna Disease Virus and its Role in Neurobehavioural Disease

Edited by K.M. Carbone
Published by American Society for Microbiology (2002)
US$ 99.95/£82.50, pp. 252
ISBN: 1-55581-235-X

This is a fascinating book describing discovery, virology, diagnosis, epidemiology and animal models of pathogenesis of Borna disease virus (BDV), a non-segmented negative-strand RNA virus classified in a new virus family. This virus was first found to infect horses, but has a wider host spectrum. BDV infection has recently been implicated in the development of neuropsychiatric disorders in man. Although there is now consensus that humans are susceptible to BDV infection, the clinical consequences of human infection remain controversial. The virus is difficult to work with, and the various chapters reflect this appropriately. Outlooks on future BDV research are particularly interesting. The book is highly recommended to all interested in virology, viral pathogenesis and mammalian neurological disease.

■ ***Ulrich Desselberger***
INRA, Jouy-en-Josas, France

The Macrophage, Second Edition

Edited by B. Burke & C.E. Lewis
Published by Oxford University Press (2002)
£75.00, pp. 647
ISBN: 0-19-263197-7

This multi-authored book charts the life of the macrophage in a variety of systems ranging from antimicrobial defence to immunological and other systems disorders. There is a comprehensive overview chapter on the biology of the macrophage and its myriad of functions and a chapter dealing with macrophage activation and gene expression. Microbiologists will find the chapters devoted to macrophage interactions with viruses, bacteria and parasites particularly informative. These are comprehensive overviews in some cases reflecting the research interests of the authors. For example, the chapter by Zink *et al.* on virus–macrophage interactions emphasizes viruses important in nervous system diseases. Other chapters of note include macrophages in wound healing and tumour biology, and the inclusion of chapters dealing with macrophages in gene therapy and the use of mathematical modelling to study the dynamics of macrophages in various disorders. Overall, this is a very useful reference source and a must for all libraries.

■ ***Tony Nash***
University of Edinburgh

The Microbiological Risk Assessment of Food

By S.J. Forsythe
Published by Blackwell Science (2002)
£29.95, pp. 216
ISBN: 0-632-05952-4

This book should serve as background reading for those interested in the field of microbial risk assessment. It broadly covers the benefits for using this technology and gives adequate examples where this technology

has been applied. It also lists together most of the information sources currently available in this field. This I think is the strong point of this book. It summarizes the current information on microbial risk assessment and should therefore benefit researchers going into this field. However, chapter 3 of the book could also benefit from a more extensive discussion of uncertainty and variability. Strong information theoretic methods are the basis for good risk assessment.

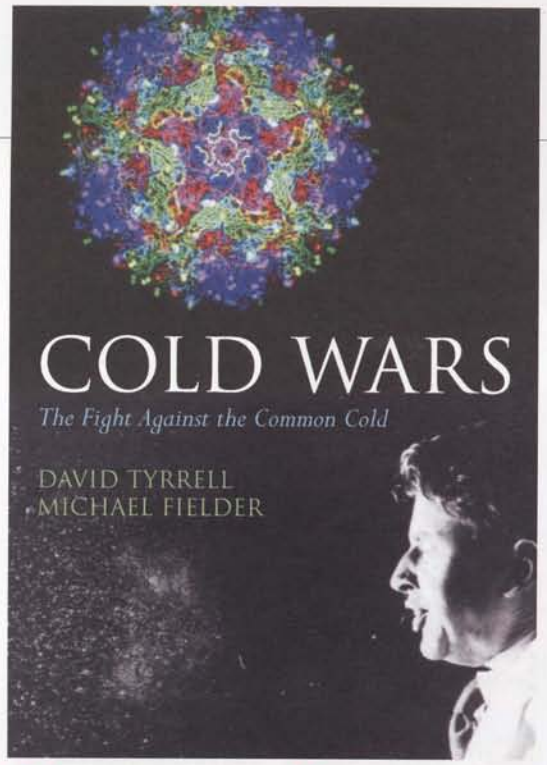
■ ***Pradeep Malakar***
Institute of Food Research, Norwich

Who Wants to be a Scientist? Choosing Science as a Career

By N. Rothwell
Published by Cambridge University Press (2002)
HB £40.00/PB £14.95, pp. 166
ISBN: HB 0-521-81773-0; PB 0-521-52092-4

Although the title of this book suggests that it is about science careers in general, the bulk of the contents concentrates on career development for academic scientists. It begins with advice on finding a PhD studentship, life as a student researcher, thesis writing, progresses through working as a post-doc and the transition to research group leader, right through to aiming for more senior roles. A little coverage is given to working outside the academic environment. The author gives some very useful tips on subjects such as networking, presenting work at conferences and grant applications. She does this is an entertaining way, but with a certain amount of authority.
The book spans a 30–40 year career in 166 pages and is a useful insight to careers in a research oriented university department. I would recommend it to anyone at the earlier stages of their career, but do not think that it offers quite so much to the more senior scientist.

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



Cold Wars: The Fight Against the Common Cold

By D. Tyrrell & M. Fielder
Published by Oxford University Press (2002)
£17.99, pp. 272
ISBN: 0-19-263285-X

Personal reminiscences have a way of illuminating the dusty corners of medical research and vitalizing dry facts in scientific records. As a graduate student struggling with the concepts underlying virus research, it was often a source of puzzlement as to why certain techniques came to be used, or how various animal models were ever discovered. Serendipity and a systematic approach can be equally important in developing knowledge and, when combined, are powerful investigative tools, as this book reminds us. In these days of highly efficient multinational research consortia, it is easy to overlook the contribution of personal insight into the development of a field of science. Such perspectives are engagingly described in the personalized record of a well loved, but now sadly defunct Common Cold Unit (CCU).
This book is highly recommended for all involved in human virus research, particularly respiratory virus research, including those with a living memory of the CCU who will enjoy the anecdotes, as well as those for whom CCU exists only as a legend. For the latter individuals this book should provide fascinating insights into the halcyon days of experimental human virology before SOPs, COSHH and risk assessments.

■ ***Maria Zambon***
Central Public Health Laboratory, London

Molecular Infection Biology: Interactions Between Microorganisms and Cells

Edited by J. Hacker & J. Heesemann
Published by John Wiley & Sons (2002)
Euro88.90/£55.95, pp. 340
ISBN: 0-471-17846-2

I read *Molecular Infection Biology* with great interest and I found it enjoyable and extremely useful. Initially, having glanced at the title, I thought I would only have enough time to flick through it and read selected chapters. I later found myself reading it almost back to back! No kidding!
The title of the book is different from the usual molecular or medical microbiology books, and so is the content. The book consists of 23 succinct, concept-driven and beautifully structured chapters. It covers a wide range of fundamental aspects of pathogenesis of microbial diseases, including the mechanisms of microbial survival and virulence, protein secretion, the host response to infection and state-of-the-art technologies employed in research. The authors have made a brave and successful attempt to explain a wide range of complex molecular themes that would enable students to better understand molecular microbiology publications. It should also help non-molecular biologists, such as clinical microbiologists or others outside the field but with interest in infection, to dig deep in host–pathogen interaction at the molecular level.
There are chapters on the bacterial population genetics, evolution, antigenic variation, vaccines, immune responses, *in vitro* models and, uniquely, new areas like microarrays, functional genomics and proteomics. They give just about enough information to make the subject crystal clear and without making them sound dull. I have already begun recommending the book to our postgraduate students engaged in research (e.g. first year PhD students) or taught courses (e.g. our MSc in Molecular Medical Microbiology).

■ ***Del Ala'Aldeen***
University of Nottingham

E. coli Gene Expression Protocols. Methods in Molecular Biology Vol. 205

Edited by P.E. Vaillancourt
Published by Humana Press (2002)
US$99.50, pp. 368
ISBN: 1-58829-008-5

This compendium of 23 articles, each written by hands-on experts, describes many established and emerging methodologies for expressing recombinant proteins in *E. coli*. The focus is on two main areas: the *E. coli* strains and vectors that optimize production of soluble, functional protein; and use of *E. coli* as a host for the screening of large collections of proteins and peptides (e.g. phage display, the *E. coli* two-hybrid system, *in vivo* enzyme screening). As with the earlier volumes of this series, each chapter provides step-by-step protocols and tips for how to avoid the usual problems. There is by no means complete coverage of every possible aspect of *E. coli* expression, and some duplication in the protocols provided. Nevertheless many will find it extremely useful to have this book to hand when trying to achieve high levels of pure, soluble recombinant protein; or incorporating an *E. coli* expression step into the procedures of functional genomics, proteomics and protein engineering.

■ ***Peter W. Piper***
University College London

Mechanisms of Resistance to Plant Diseases

Edited by A.J. Slusarenko, R.S.S. Fraser & L.C. van Loon
Published by Kluwer Academic Publishers (2002)
Euro75.00/US$70.00/£47.00, pp. 620
ISBN: 1-4020-0399-4

This volume is a paperback digital reprint of a hard-back version that was originally published in 2000. Reprinting has had a major impact on the price, making this edition much cheaper than the hard-back and probably affordable to individual researchers who should find it a useful source of background information. It will certainly be valuable to lecturers in plant pathology, microbiology, biochemistry and molecular biology, giving a compact resource for updating in this expanding area of research. Unfortunately, the printing process has also markedly reduced the quality of the illustrations, so those wishing to produce slides to illustrate lectures will need to obtain an original edition.
The volume is well structured and comprehensive. Other than in superficial basic texts, it is unusual to find such breadth of coverage of plant disease resistance (even including much neglected structural defences), with excellent analysis by experts in their fields of research.

■ ***Harry Epton***
University of Manchester

Microorganisms in Plant Conservation and Biodiversity

Edited by K. Sivasithamparam, K.W. Dixon & R.L. Barrett
Published by Kluwer/Plenum Publishers (2002)
US$119.00/£81.50/Euro129.00, pp. 378
ISBN: 1-4020-0780-9

I think any book that highlights this issue deserves support. All too frequently micro-organisms have been the poor relations to the higher profile requirement to

preserve plant and animal biodiversity. The role micro-organisms play in supporting (or damaging!) the life cycles of plant species is becoming clearer as is the need to preserve their diversity. The Editors and authors deserve credit for highlighting this issue and the dire consequences that could arise if we fail to heed their warning. Although the publicity associated with this book highlights its attempt to '*bring to the fore the ecological underwriting provided by micro-organisms*', I think the contributions taken together only achieve this to a limited extent. For example there is no coverage of molecular ecology and its value in this area. Related to this and possibly reflecting any own bias, I found the coverage of bacterial issues a little cursory. This said I don't want to detract from what is a fair stab at pulling together all of the major issues and recent developments and would highlight the comprehensive treatment of mycorrhizal fungi in particular. A good book for the specialist, though possibly more so for those of us with a more mycological bent.

■ ***Gerry Saddler***
Scottish Agricultural Science Agency, Edinburgh

Escherichia coli: Virulence Mechanisms of a Versatile Pathogen

Edited by M.S. Donnenberg
Published by Academic Press (2002)
US$99.95, pp. 400
ISBN: 0-12-220751-3

This book continues the successful range of microbiology texts from Academic Press. This volume is mainly directed towards researchers interested in the pathogenesis of *E. coli* and is not necessarily intended for the undergraduate market. The Editor has drawn upon the expertise of primarily (ca 95%) US-based authors, to address virulence aspects in different strains of the organism. An emphasis is placed throughout on recent molecular advances and the book is therefore timely in nature. The contributors have done well to keep the material up-to-date in what is a fast moving area. Most chapters principally cite references from 2000 onwards. Mechanistic explanations on *E. coli* genomics, evolution and virulence are given and much light is therefore shed upon this ubiquitous microbe. Little overlap occurs between the chapters which follow a similar format in terms of historical aspects, graphics and individual strain examples. Overall, this is a very informative book which is well presented and would be excellent value for money for scientists generally interested in the basis of microbial pathogenesis, as well as *E. coli* specifically.

■ ***Glenn Gibson***
University of Reading

Mycobacteria and TB. Issues in Infectious Diseases, Vol. 2

Edited by S.H.E. Kaufmann & H. Hahn
Published by S. Karger AG Basle (2003)
SFr169.00/Euro120.50/US$147.00, pp. 156
ISBN: 3-8055-7459-2

This slim volume on tuberculosis is admirable in its brevity and in its clarity. The title reflects a focus in many chapters on the bacterium and its role in pathogenesis (rather than, for example, on clinical issues). There are nine chapters written by experts in their fields, covering TB as a global public health problem, molecular epidemiology, the status of BCG, laboratory diagnosis, chemotherapy and drug resistance, molecular biology, immunology and persistence, and the development of new vaccines and drugs. Chapters are extremely clearly written, and many (importantly) contain a historical perspective as well as describing the current state of knowledge. My only criticism would be to ask for more; for example, something on clinical disease would help balance molecular, cellular and epidemiology perspectives. Yet the conciseness of the book is also a strength. I recommend this unreservedly as a primer on tuberculosis, and will use it myself for reference.

■ ***Neil Stoker***
Royal Veterinary College, London

Frontiers in Computational Genomics. Functional Genomics Series, Vol. 3

Edited by M.Y. Galperin & E.V. Koonin
Published by Caister Academic Press (2002)
£90.00/US$180.00, pp. 348
ISBN: 0-9542464-4-6

'*Genomics is primarily computational*' say the Editors of this collection of topics ranging from gene prediction, protein alignment, molecular modelling, and genome-scale phylogenetic trees. It is clearly aimed at biologists rather than computer scientists, although the chapter on modelling proteome evolution will be less accessible to those without a background in mathematics. Microbiologists may enjoy chapters exploring the evolution of ABC transporters and signal transduction systems, and the evolution of prokaryotic regulatory networks. The chapter on domains and motifs will be useful to biologists trying to predict function from sequence. Computational biology is symbiotic with wet-lab research, as reflected in the chapter on 'experimental RNomics'. This book is not intended as a general introduction to computational genomics; other texts provide that role and the price may deter many from buying a personal copy. However, it would be a valuable addition to any lab or departmental library.

■ ***Dave Studholme***
Wellcome Trust Sanger Institute.

Settleability Problems and Loss of Solids in the Activated Sludge Process

By M.H. Gerardi
Published by Wiley Interscience – John Wiley & Sons (2002)
£37.50, pp. 179
ISBN: 0-471-20694-6

This is the second book in the *Wastewater Microbiology* series published by Wiley Interscience. However, it need not be studied in tandem with the first. Alone this is still a comprehensive text, written in a straightforward manner. Although it is an applied book, targeted at personnel working in the water treatment industry, it is an interesting read even for those with only a passing interest. The author introduces each topic to give a sound background to the science concerned although many microbiologists may find this a little basic. It is mainly a troubleshooting guide for technicians and operators and, as such, the graphical and tabular data often leave something to be desired. The sketchy diagrams are fine for those involved in the process, but further detail would be helpful for the less knowledgeable. A competent series of micrographs and diagrams of the microflora and fauna present are particularly valuable for those studying this side of the process. A useful glossary of abbreviations and a quick refresher of techniques used are included as appendices and help to clarify the text for those not fluent in the industry's language. All in all it is an excellent example of applied and troubleshooting microbiology.

■ ***Joanna Heaton and Keith Jones***
Department of Biological Sciences, Lancaster University

Anthrax. Current topics in Microbiology and Immunology, Vol. 271

Edited by T.M. Koehler
Published by Springer (2002)
Euro89.95/SFr149.50/£63.00/US$99.00, pp. 169
ISBN: 3-540-43497-6

Interest in anthrax largely occurs in waves as international concern over its intentional release waxes and wanes. This monograph concentrates on research from the 1990s with a fascinating historical introduction by Turnbull. Six chapters cover the biology of the organism in varying detail indicative of the information base. Contributions on 'Toxins' (Lacy & Collier) and 'Interactions with Macrophages' (Guidi-Rontani & Mock) are comprehensive. An account of the cell envelope by Fouet & Mesnage highlights the lack of research

Publisher's website addresses

Academic Press	www.academicpress.com
ASM Press	www.asmpress.org
BIOS	www.bios.co.uk
Blackwell Science	www.blackwellpublishing.com
Caister Academic Press	www.caister.com
Cambridge University Press	uk.cambridge.org
Denisia, Museum of Upper Austria	e.aescht@landesmuseum-linz.ac
Humana Press	www.humanapr.com
Karger, S.	www.karger.com/iinfd
Kluwer Academic/Plenum	www.wkap.nl
Oxford University Press	www.oup.co.uk
Sinauer Associates	www.sinauer.com
Springer	www.springer.de
Wiley	www.wileyeurope.com

in this area, particularly in capsule biosynthesis. The fairly primitive status of the human vaccine is covered by Friedlander *et al.* and the renaissance in molecular systematics and evolution is ably reviewed by Keim & Smith. Finally, the Editor's contribution on virulence gene regulation usefully includes genetic manipulation. A highly readable short book that provides an authoritative account of the current status of anthrax and highlights the need for further work in several areas.

■ ***Fergus Priest***
Heriot-Watt University

Cases in Medical Microbiology and Infectious Diseases, Third Edition

By P.H. Gilligan, M.L. Smiley & D.S. Shapiro
Published by American Society for Microbiology (2003)
£29.95/US$49.95, pp. 440
ISBN: 1-55581-207-4

A user-friendly introduction is followed by an excellent section detailing the procedures used during laboratory diagnosis, including their inherent strengths and weaknesses. As well as facilitating insight for medics with minimal knowledge of the more sophisticated molecular diagnostic procedures, this is very useful revision for the more experienced. The seven main chapters containing the 68 clinical cases have been logically organized based upon organ systems. Each clinical case is initially outlined followed by a series of questions that probe knowledge concerning the nature of the etiological agent and diagnostic approaches, clinical manifestation of the infection, epidemiology, and rational treatment protocol. Photographs, illustrating the organisms' microscopic and colonial appearance, adequately support each chapter. Whilst targeted at a very specific audience, the book succeeds in its intended goal of challenging the reader to gain an understanding of the micro-organisms responsible for causing infection and to develop clinical problem solving skills allowing for differential diagnosis.

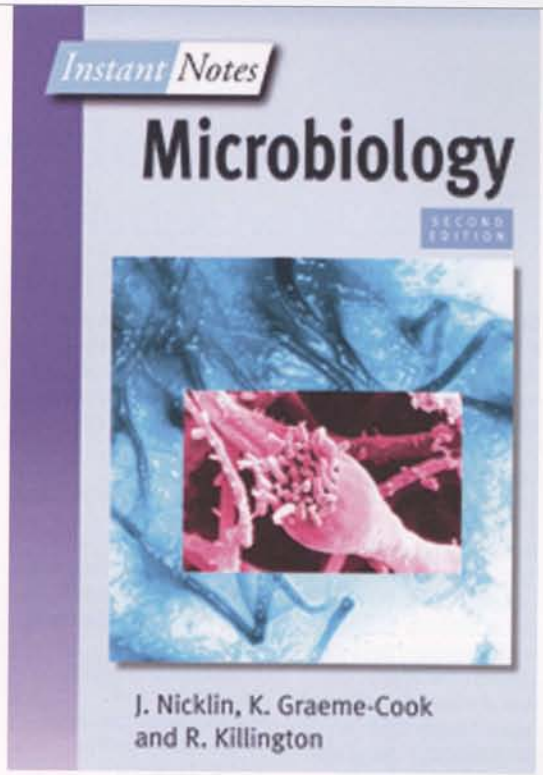
■ ***Andrew Lamb***
The Robert Gordon University, Aberdeen

Halophilic Microorganisms and their Environments

By A. Oren
Published by Kluwer Academic Publishers (2002)
Euro206.00/US$197.00/£132.00, pp. 575
ISBN: 1-4020-0829-5

Although there have been a number of books devoted to halophiles (usually symposia proceedings), there are only two single-author monographs on the topic – an excellent book by Barbara Javor [*Hypersaline Environments* (Brock-Springer 1989)] that for the first time attempted to interface halophile biology with geochemistry/ geology, and now this book, written by one of the doyens of the halophile world. The book builds on Javor's book, but covers much, much more. The 18 chapters range from historical aspects of salt manufacture, through the systematics, ecology, physiology and molecular biology, to recent interest in halophiles and astrobiology – every conceivable topic is here. Aharon Oren has managed the difficult tasks of making the book accessible to the non-specialist and, simultaneously, enormously detailed and extensively referenced (right up to the date of publication). If you want to get into halophile research from scratch, or if you want to pick up on any halophile topic at an advanced level, this is the book. A tour de force that will be indispensable for halophilologists for years to come.

■ ***Bill Grant***
University of Leicester



Haemophilus influenzae Protocols. Methods in Molecular Medicine, Vol. 71

Edited by M.A. Herbert, D.W. Hood & E.R. Moxon
Published by Humana Press (2002)
US$119.50, pp. 344
ISBN: 0-89603-928-5

Methods tend to be variations on a theme, with improvizations by individual laboratory workers, so methods books run the risk of being unnecessarily prescriptive. Not this book, which is authoritative, thorough and accurate. There is some unnecessary repetition. For example, why two review chapters about disease caused by *H. influenzae*? Why is Tn*10* covered in Chapter 12, to be followed by Chapter 13 devoted to Tn*10*? There are some tiny omissions, such as no mention of a method for making Levinthal's blood in Chapter 3 (although this is covered in a later chapter), and some proof-reading howlers (for example in Chapter 3, Table 1 is given in the text, but the sole table in the chapter is labelled as Table 3). This book is most useful to those starting to work with this bacterium. I cannot see there being a big demand for it, especially given its rather high price.

■ ***Duncan Maskell***
University of Cambridge

Instant Notes: Microbiology, Second Edition

By J. Nicklin, K. Graeme-Cook & R. Killington
Published by BIOS (2002)
£15.99, pp. 330
ISBN: 1-85996-267-X

The second edition of this popular *Instant Notes* format covers a full range of microbiology: bacterial, archaeal, viral, protozoal, fungal and prional in only 330 pages. The book does what it sets out to do and gives key facts on the major important areas. It will be popular with students due to its affordability and simplicity of its diagrams. Phylogenetic relationships are discussed for the bacteria and a suggestion for a future revision would be to remove more of the taxonomic details and introduce phylogenetic relationships for the viruses along with a short discussion of the origins of HIV. Also the flagellar diagram in bacterial structure could do with updating. These are very minor suggestions and the authors are to be congratulated on the quality of what they have packed into this study guide. I cannot imagine anyone producing a better version at the same affordable price for students.

■ ***Liz Sockett***
University of Nottingham

Cancer: the Evolutionary Legacy

By M. Greaves
Published by Oxford University Press (2001)
£9.99, pp. 276
ISBN: 0-19-262834-8

This is an agreeable book, written by a respected UK authority. It will interest the expert in other scientific areas and is also accessible to the reasonably well-informed layperson. Mel Greaves covers many topics on historical, medical, epidemiological and molecular aspects of cancer, describing many specific types in detail. His unifying theme is the analogy between evolutionary processes and the emergence of the final cancer cell: both involving contingent combinations of chance genetic events, selection, and genetic drift via bottlenecks. This viewpoint is not new but may be unfamiliar to some, and is pursued tenaciously but fair-mindedly. The author points to ways in which both human biology and human society have developed to allow cancers to have become so common and serious, such as longevity and the human (and great ape) female reproductive cycle on the one hand, and effects of diet and life style on the other. He stresses the importance of environmental factors within the individual's control, such as smoking, as against those such as industrial pollutants which would make us all involuntary victims. Virus involvement is covered in two brief chapters. An attraction of the book, at least to those like myself who, jackdaw-like, enjoy random bits of information, is the wealth of historical anecdote; e.g. that Napoleon probably carried a gene for predisposition to gastric cancer. Sensibly for a book aimed at a lay audience, there are few diagrams; however, the many illustrations are illuminating, such as the comparison of English and Western European chimney sweeps' work clothes (the latter suffered much less from scrotal cancer). Thoroughly recommendable.

■ ***Simon Baumberg***
University of Leeds

Viral Proteins Counteracting Host Defenses. Current Topics in Microbiology and Immunology, Vol. 269

Edited by U.H. Koszinowski & H. Hengel
Published by Springer (2002)
Euro99.95/SFr 166.00/£70.00/US$109.00, pp. 325
ISBN: 3-540-43261-2

The mechanisms of the interaction between viruses and the host immune system have been an area of very active research in the past decade. Many viruses have evolved proteins which subvert the immune system and probably contribute to latent and persistent infections. This volume provides a reasonably comprehensive and timely review of this area, focussing mainly on herpesviruses. This might be regarded as a restricted view of the area, but many of the most well-studied evasion mechanisms have utilized herpesviruses systems. Well-known herpesviruses are covered in detail, including cytomegalo-viruses, herpes simplex virus and the gamma herpesviruses, Epstein–Barr virus and Kaposi's sarcoma herpesvirus. In addition, there is an excellent chapter on adenoviruses, which provided early paradigms for subsequent study in more complex virus systems as well as a thoughtful introductory chapter, which reviews the methodology used in such studies.

■ ***Eric Blair***
University of Leeds

Hepatitis C Virus: From Laboratory to Clinic

By M.A. Feitelson
Published by Cambridge University Press (2002)
£32.95/US$48.00, pp. 256
ISBN: 0-521-79959-7

This book embraces a wide range of topics on HCV, providing perspectives on both clinical manifestations of the virus and the current themes in fundamental research. It also encompasses a temporal description from the discovery of the virus to the emerging discoveries that may lead to novel antiviral therapies. To some extent, the broad scope of the content is the book's Achilles' heel since the coverage of certain topics lacks the depth needed for a comprehensive description. Nonetheless, the section on 'Basic principles' gives a considered overview of the central features of the virus. I would recommend the book to students or investigators who want an introduction to HCV and are interested in the issues surrounding the problems with understanding the virus life cycle. For such an audience, an extensive list of references also is provided that offers a useful guide to the literature on HCV.

■ ***John McLauchlan***
MRC Virology Unit, Glasgow

Microbial Life

By J.J. Perry, J.T. Staley & S. Lory
Published by Sinauer Associates (2002)
£35.99, pp. 811
ISBN: 0-87893-675-0

An undergraduate textbook that '*focuses on the microbe itself rather than diseases that might be caused by micro-organisms*'. I welcome this approach which is also a characteristic of Brock's *Biology of Micro-organisms* and which produces a much more holistic and less medical view of the importance of micro-organisms in life on earth. Good features of this text include boxed sections on 'Milestones in microbiology' or 'Research highlights', a commendable amount of modern phylogenetics and genomics, and some good diagrams of bacteriorhodopsin and ATP synthase. Weaknesses include some problematic typographical errors, e.g. reoviruses on p. 299 are mispelled as retroviruses, and some out-of-date diagrams that no longer accurately represent cellular structures, such as the flagellum on p. 97. These points detract from what is otherwise a textbook definitely on the right track for teaching modern molecular microbiology and getting students to see how experimentation informs microbial knowledge.

■ ***Liz Sockett***
University of Nottingham

Bacillus subtilis and its Closest Relatives: from Genes to Cells

Edited by A.L. Sonenshein, J.A. Hoch & R. Losick
Published by American Society for Microbiology (2001)
US$149.95, pp. 650
ISBN: 1-55581-205-8

The predecessor of this book, *Bacillus subtilis: the Model Gram-Positive Organism*, appeared in 1993. The change in name is significant in two ways. First, the earlier book covered Gram-positives distant from the bacilli, notably *Staphylococcus* and *Streptomyces*; its successor doesn't. Second, this book stops at cells: there's no equivalent to the 'Systematics and ecology' chapter that started the 1993 volume. Between the two lies the completion of the *B. subtilis* genome sequence in 1997, which gives focus throughout to the present work. The book is in six sections (of varied length): a genomic view, cell architecture, chromosome replication and cell division, metabolism and its regulation, macromolecular synthesis, and adaptation and differentiation, of which the final section is the longest, amounting to a third of the book – reasonably, in view of our increasingly detailed understanding of sporulation among other things. Each chapter is an authoritative and concise account of its field, the editing is impeccable, and the production excellent. It is not really a criticism to suggest that anyone not already expert will probably need to look at the earlier volume as well. Taking an almost random example – I've picked this area just because I'm not a specialist – the 1993 chapter by Saier and colleagues contains a superb account of different transport ATPases recommendable to anyone wishing to gain entry to this area of cell biology. In the 2002 volume, this aspect has been slimmed down, though not eliminated entirely, in order to deal with the transporters and homologues recognizable in *B. subtilis*. Still, any *Bacillus* lab has to have this book, and any group or department seriously interested in bacterial molecular physiology and genetics must have access to it.

■ ***Simon Baumberg***
University of Leeds

Molecular Plant Biology, Vol. 2. Practical Approach Series No. 259

Edited by P.M. Gilmartin & C. Bowler
Published by Oxford University Press (2002)
£35.00, pp. 332
ISBN: 0-19-963818-7

Research techniques have moved on dramatically since the first *Practical Approach* book dedicated to plant molecular biology was published in 1988. This two-volume publication is therefore welcome, and very much in the spirit of the series, with each chapter focusing on a particular methodology and providing clear experimental protocols. The second volume covers techniques for analysing gene expression and for investigating the function of gene products *in vitro* and *in vivo*. The chapters are well written, with sufficient background detail and a step-by-step guide to each technique. Overall, this will be a useful manual for any plant molecular biology laboratory. However, a minor criticism is that some of the chapters seem out of place in this particular volume in that they cover rather general techniques that are not specific to plant research. For example, those chapters on the production of recombinant proteins, the use of yeast two-hybrid systems and the production of antibodies.

■ ***Saul Purton***
University College London

Encyclopedia of Dairy Sciences (4-volume set)

Edited by H. Roginski, J.W. Fuquay & P.F. Fox
Published by Academic Press (2002)
US$925.00/£620.00, pp. 2,000
ISBN: 0-12-227235-8

The *Encyclopedia* is, academically and physically, an impressive work, covering a very wide range of topics extending beyond milk, its production and its processing to less obvious subject areas, such as the origin of mammals. An equally wide range of specialists has contributed to the book, bringing a truly international dimension to the work. Inevitably, many of the entries discuss topics that are not of direct concern to the microbiologist and the information contained in the four volumes is intended for the use of many dairy-related disciplines. The *Encyclopedia* does, however, cover all of the important aspects of microbiology, the coverage is comprehensive, up-to-date and of a depth at least sufficient to answer a query or to provide a solid foundation for a more specific search. Standards of writing and editing are high and a high level of coherence is achieved despite the presentation of data as discrete topics. In comparison with some similar books, navigation and entry finding is straightforward. The microbiology of foods cannot be considered in isolation to the technology and an advantage of an encyclopedia is the ease with which the technical background, from the processor back to the farm, can be researched. In conclusion, the *Encyclopedia* forms an excellent resource of value to many different people in many different situations. Acquisition by libraries can be recommended.

■ ***Alan Varnam***
London Metropolitan University

Address Book

Council 2002–2003

Officers

President
PROF. SIR DAVID HOPWOOD
John Innes Centre,
Norwich Research Park,
Colney,
Norwich NR4 7UH
Tel. 01603 450000
01603 450338 (direct)
Fax 01603 450045
email david.hopwood@bbsrc.ac.uk

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

General Secretary
PROF. ALAN VIVIAN
Centre for Research in Plant Science,
Faculty of Applied Sciences,
University of the West of England,
Coldharbour Lane,
Bristol BS16 1QY
Tel. 0117 344 2470
Fax 0117 344 2904
email alan.vivian@uwe.ac.uk

Scientific Meetings Officer
PROF. HOWARD JENKINSON
Dept of Oral and Dental Science,
Division of Oral Medicine,
Pathology and Microbiology,
University of Bristol Dental Hospital and School,
Lower Maudlin Street,
Bristol BS1 2LY
Tel. 0117 928 4358 (direct)
0117 928 4304 (office)
Fax 0117 928 4428
email howard.jenkinson@bristol.ac.uk

International Secretary
PROF. SIR JOHN E. BERINGER
School of Biological Sciences,
University of Bristol,
Wood land Road,
Bristol BS8 1UG
Tel. 0117 928 7471
Fax 0117 925 7374
email j.beringer@bristol.ac.uk

Professional Affairs Officer
DR GEOFFREY C. SCHILD
email the.schilds@btinternet.com

Editor, Microbiology Today
DR MERIEL G. JONES
The School of Biological Sciences,
The Biosciences Centre,
Crown Street,
Liverpool L69 7ZB
Tel. 0151 795 4562
Fax 0151 795 4410
email meriel.jones@liv.ac.uk

Editor-in-Chief, Microbiology
PROF. CHRISTOPHER M. THOMAS
School of Biosciences,
University of Birmingham,
Edgbaston,
Birmingham B15 2TT
Tel. 0121 414 5903
Fax 0121 414 5925
email c.m.thomas@bham.ac.uk

Editor-in-Chief, JGV
PROF. GEOFFREY L. SMITH
Dept of Virology,
Faculty of Medicine,
Imperial College,
St Mary's Campus,
Norfolk Place,
London W2 1PG
Tel. 0207 594 3972
Fax 0207 594 3973
email glsmith@ic.ac.uk

Editor-in-Chief, JMM
PROF. IAN R. POXTON
Dept of Medical Microbiology,
University of Edinburgh
Medical School,
Teviot Place,
Edinburgh EH8 9AG
Tel. 0131 650 3128
Fax 0131 650 3128
email i.r.poxton@ed.ac.uk

Members

PROF. PETER W. ANDREW
Dept of Microbiology and Immunology,
University of Leicester,
University Road,
Leicester LE1 9HN
Tel. 0116 252 2941
Fax 0116 252 5030
email pwa@leicester.ac.uk

PROF. ALISTAIR J.P. BROWN
Molecular and Cell Biology,
Institute of Medical Sciences,
University of Aberdeen,
Foresterhill,
Aberdeen AB25 2ZD
Tel. 01224 555883
Fax 01224 555844
email al.brown@abdn.ac.uk

PROF. JEFF A. COLE
School of Biosciences,
University of Birmingham,
Edgbaston,
Birmingham B15 2TT
Tel. 0121 414 5440
Fax 0121 414 5925
email j.a.cole@bham.ac.uk

PROF. JEFF ERRINGTON
Sir William Dunn School of Pathology,
University of Oxford,
South Parks Road,
Oxford OX1 3RE
Tel. 01865 275561
Fax 01865 275556
email jeff.errington@path.ox.ac.uk

DR PAULINE S. HANDLEY
School of Biological Sciences,
1.800 Stopford Building,
University of Manchester,
Oxford Road,
Manchester M13 9PT
Tel. 0161 275 5265
Fax 0161 275 5656
email p.handley@man.ac.uk

PROF. COLIN R. HOWARD
The Royal Veterinary College,
Royal College Street,
Camden,
London NW1 0TU
Tel. 020 7691 2066
Fax 020 7419 5983
email choward@rvc.ac.uk

DR KEITH JONES
Dept of Biological Sciences,
IENS,
University of Lancaster,
Lancaster LA1 4YQ
Tel. 01524 593993
Fax 01524 843854
email k.jones@lancaster.ac.uk

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

PROF. HILARY M. LAPPIN-SCOTT
School of Biological Sciences,
Exeter University,
Hatherly Laboratories,
Prince of Wales Road,
Exeter EX4 4PS
Fax 01392 263700
email h.m.lappin-scott@exeter.ac.uk

PROF. TONY A. NASH
Dept of Veterinary Pathology,
University of Edinburgh,
Summerhall,
Edinburgh EH9 1QH
Tel. 0131 650 6164
Fax 0131 650 6511
email tony.nash@ed.ac.uk

PROF. IAN S. ROBERTS
School of Biological Sciences,
1.800 Stopford Building,
University of Manchester,
Oxford Road,
Manchester M13 9PT
Tel. 0161 275 5601
Fax 0161 275 5656
email isrobert@fs1.scg.man.ac.uk

Group Conveners

Cells & Cell Surfaces
PROF. C. DAVID O'CONNOR
Biochemistry & Molecular Biology
School of Biological Sciences,
University of Southampton,
Bassett Crescent East,
Southampton SO16 7PX
Tel. 02380 594336 (direct)
02380 594338 (secretary)
Fax 02380 594459
email doc1@soton.ac.uk

Clinical Microbiology
PROF. STEPHEN H. GILLESPIE
Dept of Medical Microbiology,
Royal Free & University College Medical School,
Rowland Hill Street,
London NW3 2PF
Tel. 0207 794 0500
Fax 0207 794 0433
email stepheng@rfc.ucl.ac.uk

Clinical Virology
DR TIM WREGHITT
Clinical Microbiology and Public Health Laboratory,
Addenbrooke's Hospital,
Cambridge CB2 2QW
Tel. 01223 257029
Fax 01223 242775
email tim.wreghitt@addenbrookes.nhs.uk

Education & Training
PROF. JOANNA VERRAN
Dept of Biological Sciences,
Manchester Metropolitan University,
Chester Street
Manchester M1 5GD
Tel. 0161 247 1206
Fax 0161 247 6325
email j.verran@mmu.ac.uk

Environmental Microbiology
DR KIRK T. SEMPLE
Dept of Environmental Science,
Institute of Environmental and Natural Sciences,
University of Lancaster,
Lancaster LA1 4YQ
Tel. 01524 594534
Fax 01524 593985
email k.semple@lancaster.ac.uk

Eukaryotic Microbiology
DR CLIVE PRICE
Dept of Biological Sciences,
University of Lancaster,
Lancaster LA1 4YQ
Tel. 01524 593137
Fax 01524 843854
email c.price1@lancaster.ac.uk

Fermentation & Bioprocessing
DR GLYN HOBBS
School of Biomolecular Sciences,
Liverpool John Moores University,
Byrom Street, Liverpool L3 3AF
Tel. 0151 231 2198
Fax 0151 207 4726
email g.hobbs@livjm.ac.uk

Food & Beverages
DR BOB RASTALL
Food Biosciences,
University of Reading,
PO Box 226,
Whiteknights,
Reading RG6 6AP
Tel. 0118 378 6726
Fax 0118 378 0080
email r.a.rastall@reading.ac.uk

Irish Branch
DR CATHERINE O'REILLY
Dept of Chemical and Life Sciences,
Waterford Institute of Technology,
Cork Road,
Waterford,
Ireland
Tel. +353 51 302626
Fax +353 51 378292
email coreilly@wit.ie

Microbial Infection
DR PETRA C.F. OYSTON
Dept of Microbiology,
DSTL,
CBS Porton Down,
Salisbury SP4 0JQ
Tel. 01980 613641
Fax 01980 614307
email pcoyston@dstl.gov.uk

Physiology, Biochemistry & Molecular Genetics
PROF. GEORGE SALMOND
Dept of Biochemistry,
University of Cambridge,
Tennis Court Road,
Building O,
Downing Site,
Cambridge CB2 1QW
Tel. 01223 333650
Fax 01223 333345
email gpcs@mole.bio.cam.ac.uk

Systematics & Evolution
DR GERRY SADDLER
Scottish Agricultural Science Agency,
82 Craigs Road,
East Craigs,
Edinburgh EH12 8NJ
Tel. 0131 244 8925
Fax 0131 244 8940
email gerry.saddler@sasa.gsi.gov.uk

Virus
PROF. RICHARD E. RANDALL
School of Biology,
Biomolecular Sciences Building,
University of St Andrews,
North Haugh,
St Andrews,
Fife KY16 9ST
Tel. 01334 463397
Fax 01334 462595
email rer@st-and.ac.uk

Diary

september 03

CHRO 2003. 12TH INTERNATIONAL WORKSHOP ON *CAMPYLOBACTER, HELICOBACTER* AND RELATED ORGANISMS

Aarhus, Denmark
6–10 September 2003

CONTACT: CHRO 2003, c/o Kongreskompagniet (Tel. +45 8629 6960; Fax +45 8629 6980; email kontakt@kongreskompagniet.dk; www.chro2003.dk)

57TH HARDEN CONFERENCE. PROTEINASE STRUCTURE AND FUNCTION

Oriel College, Oxford
9–13 September 2003

CONTACT: The Meetings Office, Biochemical Society, 59 Portland Place, London W1B 1QW (Tel. 020 7580 3481; Fax 020 7637 7626; email meetings@biochemistry.org; www.biochemistry.org/meetings/)

BIOLOGY OF TYPE IV SECRETION PROCESSES. EUROCONFERENCE ON THE MECHANISMS AND APPLICATIONS IN BIOTECHNOLOGY

Giens, France
12–17 September 2003

CONTACT: Dr J. Hendekovic, European Science Foundation, EURESCO Unit, 1 quai Lezay-Marnésia, 67080 Strasbourg Cedex, France (Tel. +33 388 76 71 35; Fax +33 388 36 69 87; email euresco@esf.org; www.esf.org/euresco/03/mc03168)

4TH INTERNATIONAL CONFERENCE ON TULAREMIA

Assembly Rooms, Bath
15–18 September 2003

CONTACT: email Tularemia@indexcommunications.com; www.tularemiaconf.co.uk

JOINT MEETING OF INTERNATIONAL BIODETERIORATION AND BIODEGRADATION SOCIETY AND INTERNATIONAL BIODETERIORATION RESEARCH GROUP ON 'MANAGEMENT AND CONTROL OF UNDESIRABLE MICROORGANISMS'

Manchester Metropolitan University
15–18 September 2003

CONTACT: Dr Joanna Verran (email j.verran@mmu.ac.uk)

FEMS Young Scientists Grants are available for this meeting.

THERMOPHILES 2003

University of Exeter
15–19 September 2003

CONTACT: Jenny Littlechild, Thermophiles 2003, Schools of Chemistry and Biological Sciences, University of Exeter, Stocker Road, Exeter EX4 4QD (Tel. 0 1392 263468; Fax 01392 263434; email j.a.littlechild@exeter.ac.uk; www.ex.ac.uk/Thermophiles 2003)

BIOTECHNOLOGY FOR THE NON-BIOTECHNOLOGIST

Rembrandt Hotel, London
25 & 26 September 2003

CONTACT: Management Forum Ltd., 48 Woodbridge Road, Guildford GU1 4RJ (Tel. 01483 570099; Fax 01483 536424; email registrations@management-forum.co.uk; www.management-forum.co.uk)

sep 03–feb 05

POSTGRADUATE CERTIFICATE/DIPLOMA IN HEALTHCARE RISK MANAGEMENT – SPECIFICALLY FOR SENIOR MANAGERS IN HEALTHCARE UNITS

Loughborough University
September 2003–February 2005

CONTACT: Joyce Bostock, Centre for Hazard & Risk Management, Loughborough University, Loughborough, LE11 3TU (Tel. 01509 222175; Fax 01509 223991; email j.g.bostock@lboro.ac.uk)

sep–oct 03

11TH INTERNATIONAL CONFERENCE ON MICROBIAL GENOMES

Durham, North Carolina, USA
28 September–2 October 2003

CONTACT: Ms Kim Y. Smith, Oak Ridge National Laboratory, PO Box 2008, Oak Ridge, TN 37831-6038, USA (Tel. +1 865 576 4860; Fax +1 865 241 0595; email smithky@ornl.gov; www.esd.ornl.gov/microbial_genomes/)

october 03

OIE THIRD INTERNATIONAL SYMPOSIUM ON BLUETONGUE

Taormina, Sicily
26–29 October 2003

CONTACT: Istituto Zooprofilattico, Sperimentale dell'Abruzzo e del Molise "Giuseppe Caporale", Campo Boario, 64100 Teramo, Italy (Tel. +39 0861 33 23 18; Fax +39 0861 33 22 51; email bt.symposium@izs.it; www.bluetonguesymposium.it)

LEGIONELLA PREVENTION TRAINING COURSE

Dunkirk, Maryland, USA
29–30 October 2003

CONTACT: Matt Freije (Tel. +1 800 801 8050; email seminars@hcinfo.com; www.hcinfo.com)

november 03

6TH OIE SEMINAR ON BIOTECHNBOLOGY AND 11TH INTERNATIONAL SYMPOSIUM OF THE WORLD ASSOCIATION OF VETERINARY LABORATORY DIAGNOSTICIANS

Bangkok, Thailand
9–13 November 2003

CONTACT: Dr A.A. Schudel, Head, Scientific & Technical Dept, OIE, 12, rue de Prony, 75017 Paris, France (Tel. +33 1 44 15 18 88; Fax +33 1 42 67 09 87; email oie@oie.int; www.oie.int)

december 03

13TH INTERNATIONAL SYMPOSIUM ON THE BIOLOGY OF THE ACTINOMYCETES

Melbourne, Australia
1–5 December 2003

CONTACT: Symposium Secretariat, c/o Conference Strategy Pty. Ltd, PO Box 1127, Sandringham, Victoria 3191, Australia (www.conferencestrategy.com.au)

CORDIA EUROPABIO CONVENTION 2003

Vienna, Austria
2–4 December 2003

CONTACT: www.cordiaconvention.com/info

january 04

HYGIENIC COATINGS & SURFACES. SECOND GLOBAL CONGRESS

Orlando, Florida, USA
26–28 January 2004

CONTACT: Janet Saraty, PRA, 8 Waldegrave Road, Teddington TW11 8LD (Tel. 020 8614 4811; Fax 020 8614 4812; email j.saraty@pra.org.uk; www.hygienic-coatings.com)

february 04

INTERNATIONAL CONFERENCE ON ANIMAL WELFARE

OIE HQ, Paris, France
23–25 February 2004

CONTACT: Dr A.A. Schudel (see above)

april 04

INTERNATIONAL CONFERENCE ON THE CONTROL OF INFECTIOUS ANIMAL DISEASES BY VACCINATION

Buenos Aires, Argentina
13–16 April 2004

CONTACT: Dr A.A. Schudel, (see above)

june 04

MANAGEMENT OF PLANT DISEASES AND ARTHROPOD PESTS BY BCAS AND THEIR INTEGRATION IN GREENHOUSE SYSTEMS (JOINT IOB/WPRS MEETING)

St. Michele, Trentino, Italy
10–13 June 2004

CONTACT: Yigal Elad, Convener (Current email during sabbatical: y.elad@sbc.bbk.ac.uk; www.agri.gov.il/Depts/IOBCPP/JGroup/IOBCWPRSintegration1st.html)

july 04

BIOSCIENCE2004: FROM MOLECULES TO ORGANISMS

SECC, Glasgow
18–22 July 2004

CONTACT: Meetings Office, Biochemical Society, 59 Portland Place, London W1B 1QW (Tel. 020 7580 3481; Fax 020 7637 7626; email meetings@BioScience2004.org; www.BioScience2004.org)

12TH INTERNATIONAL CONGRESS OF IMMUNOLOGY/4TH ANNUAL CONFERENCE OF THE FEDERATION OF CLINICAL IMMUNOLOGY SOCIETIES (IMMUNOLOGY/FOCIS 2004)

Montréal, Québec, Canada
18–23 July 2004

CONTACT: Immunology/FOCIS 2004 Secretariat, National Research Council Canada, Building M-19, 1200 Montreal Road, Ottawa, ON K1A 0R6 Canada (Tel. +1 613 993 7271; Fax +1 613 993 7250; email immuno2004@nrc.ca; www.immuno2004.org)

Comment

SARS coronavirus: in context

The rapid emergence and spread of an apparently untreatable new infectious disease – SARS – has caused consternation around the world. The cause was quickly identified as a coronavirus. Dave Cavanagh counsels that in developing strategies to deal with the SARS virus the medical profession has much to learn from experience of coronaviruses gained in a veterinary context.

The pace of progress with SARS coronavirus has been – is – breathtaking. From the index case in Hong Kong to the sequence of the whole genome (29·7 kb) took only 2 months. The structural proteins of the SARS virus have only 20–40 % identity with those in the previously known three coronavirus groups, sufficient to warrant that it be assigned to a new group, number 4. Novel though the virus is, we should look back at what we have learned with coronaviruses of veterinary importance whilst rushing forwards to combat SARS coronavirus.

Virus has been isolated in Guangdong Province from apparently healthy Himalayan palm civet cats and raccoon dogs, the virus' surface spike protein having 99 % identity to that of the human SARS isolates. Should we be surprised at the existence of such similar coronaviruses in several mammalian species? No. The fastidiousness exhibited by many coronaviruses when it comes to growth in the laboratory is not reflected *in vivo*. For example, the Group 1 Canine coronavirus can infect pigs, albeit asymptomatically. This virus, and porcine transmissible gastroenteritis coronavirus and feline coronavirus have >90 % identity in their spike protein, a determinant of host range and pathogenicity. The Group 2 bovine coronavirus has >98 % spike protein identity with a virus isolated from a child with diarrhoea, and 96 % identity with the recently discovered Group 2 respiratory coronavirus. Turkeys experimentally infected with bovine coronavirus replicated the virus, resulting in enteritis. The Group 3 coronaviruses from chickens, turkeys and pheasants differ from each other to an extent no greater than that exhibited by serotypes of the chicken coronavirus, infectious bronchitis virus (IBV).

One fear that has been voiced regarding SARS, even supposing that transmission ceases over the next few months and the link with the reservoir is not reconnected, is that it might survive in asymptomatic carriers. After inoculation with IBV at one day of age, chickens excreted virus again, detected in respiratory and faecal swabs, at 4 months of age. The trigger, it would seem, was the stress of coming into lay. About 10 % of cats become persistently infected, asymptomatic chronic shedders (for more than a year) of feline coronavirus following natural infection.

It should really come as no surprise that the SARS virus has been recovered from faeces, and for a longer period than from the respiratory tract. This happens in chickens with IBV (which is able to replicate in many alimentary tract tissues, asymptomatically, and in oviduct and kidney, sometimes causing lethal nephritis) and other coronaviruses, including human ones. If it is demonstrated that the SARS virus is growing and directly causing pathology in both the respiratory tract and the gut then that would be a first; given strains of coronaviruses, although possibly growing in both regions, cause disease in one rather than both areas.

A feature of coronaviruses that prompted speculation in the early SARS days was recombination. This has happened frequently with IBV, whilst type II feline coronaviruses are recombinants of canine and feline type I coronaviruses. Might SARS coronavirus recombine with human coronaviruses, of which there are species in coronavirus groups 1 and 2? Fortunately, the dozen or so coronaviruses of which we are aware indicate that recombination has not occurred between viruses of different groups, only within a group.

The coronavirus surface spike protein (S) is the most variable. Is the SARS virus S protein likely to mutate in man? One would imagine so, if it were to establish itself in the human community. This might be partly in response to immunity, and partly, perhaps, as it adapted to its new host, e.g. in respect of receptor specificity, as observed with murine coronavirus. Isolates of the 229E species of human coronavirus differ by 7 % in the amino-terminal (S1) half of S. Avian IBV strains differing by less than 5 % of their S1 amino acids can behave as different serotypes and can exhibit poor cross-protection, a concern for vaccine developers. There is a wealth of experience from the development of coronavirus vaccines for chickens, cattle, pigs, cats and dogs – though not all of it is encouraging. On the whole, inactivated vaccines have induced protection only poorly. Although widely used in egg-laying chickens, their purpose is to boost immunity induced by prior application of live attenuated vaccine. The spike protein alone can induce immunity, most recently demonstrated by expression from a fowl adenovirus; a single oral application protected 90–100 % of chickens. Whilst the spotlight is likely to be on the spike protein, it should not be overlooked that the internal nucleoprotein has been reported to induce protective immunity. The WHO has recommended that SARS vaccines be developed. The quickest and probably safest to develop would be an inactivated or subunit vaccine. Even if its immunogenicity were to prove less than desired, it might induce protection against the worst outcome of infection – life-threatening pneumonia.

● ***Dave Cavanagh is a virologist at the Institute for Animal Health, Compton Laboratory (dave.cavanagh@bbsrc.ac.uk). His research is focussed on coronaviruses of avian species.***

Further reading

Addie, D.D., Schaap, I.A.T., Nicolson, O. & Jarrett, O. (2003). Persistence and transmission of natural type 1 feline coronavirus infection. *J Gen Virol* 84, in press.

Johnson, M.A., Pooley, C., Ignjatovic, J. & Tyack, S.G. (2003). A recombinant fowl adenovirus expressing the S1 gene of infectious bronchitis virus protects against challenge with infectious bronchitis virus. *Vaccine* 21, 2730–2736.

Jones, R.C. & Ambali, A.G. (1987). Re-excretion of an enterotropic infectious bronchitis virus by hens at point of lay after experimental infection at day old. *Vet Rec* 120, 617–618.

Zhang, X.M., Herbst, W., Kousoulas, K.G. & Storz, J. (1994). Biological and genetic characterization of a hemagglutinating coronavirus isolated from a diarrhoeic child. *J Med Virol* 44, 152–161.

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