Microbiology TODAY

44:1 February 2017

Halting Epidemics

Ebola virus clinical and technology trials
Polio – what are the prospects for eradication?
How do epidemics become endemic?
Spotlight on leishmaniasis in India and the Middle East
Emerging infectious diseases in Asia

MICROBIOLOGY SOCIETY

CHLORAMPHENICOL

CAPSULES

Widely distributed throughout the body, including CSF[1]

Oral levels comparable to i.v. levels[2]

Rarely implicated with *C.difficile*[3,4]

Effective against serious infections including:

- *H. influenzae*[1,5]
- Typhoid[1,5]
- MRSA[2]
- VRSA[6]
- Neisseria[1,5]
- Legionella[1,5]
- Rickettsia[1,5]
- *C.difficile*[7-10]
- *E. coli*[1]

Abbreviated Prescribing Information
Chloramphenicol Capsules BP 250mg

Presentation: Hard Gelatin Capsules.
Indications: Typhoid fever and life-threatening infections, particularly those caused by *Haemophilus Influenzae*, where other antibiotics will not suffice.
Posology: For oral administration.
Adults and elderly: 50 mg/kg body weight daily in 4 divided doses. For severe infections (meningitis, septicaemia), this dose may be doubled initially, but must be reduced as soon as clinically possible. Children: Not recommended.
Contra-indications: Known hypersensitivity or toxic reaction to chloramphenicol or to any of the excipients. Should not be used for the prophylaxis or treatment of minor infections; during active immunisation; in porphyria patients; in patients taking drugs liable to depress bone marrow function; during pregnancy, labour or by breast-feeding mothers.
Special warnings and precautions for use: Use only if other treatments are ineffective. Use should be carefully monitored. Reduce dose and monitor plasma levels in hepatic or renal impairment; in the elderly; and in patients concurrently treated with interacting drugs.
Interactions: Chloramphenicol prolongs the elimination, increasing the blood levels of drugs including warfarin, phenytoin, sulphonylureas, tolbutamide. Doses of anticonvulsants and anticoagulants may need to be adjusted if given concurrently. Complex effects (increased/decreased plasma levels) requiring monitoring of chloramphenicol plasma levels have been reported with co-administration of penicillins and rifampicin. Paracetamol prolongs chloramphenicol half-life and concurrent administration should be avoided. Chloramphenicol may increase the plasma levels of calcineurin inhibitors e.g. ciclosporin and tacrolimus. Barbiturates such as phenobarbitone increase the metabolism of chloramphenicol, resulting in reduced plasma chloramphenicol concentrations. In addition, there may be a decrease in the metabolism of phenobarbitone with concomitant chloramphenicol use. There is a small risk that chloramphenicol may reduce the contraceptive effect of oestrogens. Chloramphenicol reduces the response to hydroxocobalamin. Chloramphenicol is contra-indicated in patients taking drugs liable to suppress bone marrow function e.g. carbamazepine, sulphonamides, phenylbutazone, penicillamine, cytotoxic agents, some antipsychotics including clozapine and particularly depot antipsychotics, procainamide, nucleoside reverse transcriptase inhibitors, propylthiouracil.
Pregnancy and Lactation: The use of chloramphenicol is contra-indicated as the drug crosses the placenta and is excreted in breast milk.
Effects on ability to drive and use machines: No significant effect on driving ability.
Undesirable Effects: Reversible dose related bone marrow depression, irreversible aplastic anaemia, increased bleeding time, hypersensitivity reactions including allergic skin reactions, optic neuritis leading to blindness, ototoxicity, acidotic cardiovascular collapse, nausea, vomiting, glossitis, stomatitis, diarrhoea, enterocolitis, Gray Baby Syndrome particularly in the newborn, which consists of abdominal distension, pallid cyanosis, vomiting, progressing to vasomotor collapse, irregular respiration and death within a few hours of the onset of symptoms.
Overdose: Stop chloramphenicol immediately if signs of adverse events develop. Treatment is mainly supportive. If an allergy develops, oral antihistamines may be used. In severe overdosage e.g. Gray Baby Syndrome, reduce plasma levels of chloramphenicol rapidly. Resin haemoperfusion (XAD-4) has been reported to substantially increase chloramphenicol clearance.
Pack size and Price: 60 capsules £377.00
Legal Category: POM.
Market Authorisation Number: PL17736/0075.
Market Authorisation Holder: Chemidex Pharma Limited, 7 Egham Business Village, Crabtree Road, Egham, Surrey TW20 8RB, UK.
Date of preparation: January 2016.
See Chloramphenicol Capsules Summary of Product Characteristics for full prescribing information.

Adverse events should be reported. Reporting forms and information can be found at www.mhra.gov.uk/yellowcard. Adverse events should also be reported to Essential Generics on 01784 477167.

References:
1. Martindale: The Complete Drug Reference. Chloramphenicol. [Online]. Available from: http://www.medicinescomplete.com [22nd of November 2016]. **2.** Fluit, A.C., Wielders, C.L.C., Verhoef, J., and Schmitz, F.J. Epidemiology and susceptibility of 3,051 Staphylococcus aureus isolates from 25 university hospitals participating in the European SENTRY Study. Journal of Clinical Microbiology. 2001; 39(10): 3727-3732. **3.** Kelly, C., LaMont. Patient information: Antibiotic-associated diarrhea caused by Clostridium difficile (Beyond the Basics).June 2015. **4.** Bartlett J.G. Antimicrobial agents implicated in Clostridium difficile toxin-associated diarrhea of colitis. Johns Hopkins Med J. 1981; 149(1): 6-9. **5.** Feder. H, Chloramphenicol: What we have learned in the last decade. Southern Medical Journal. 1986; (79)9: 1129-34. **6.** Weigel LM *et al.* High-Level Vancomycin-Resistant Staphylococcus aureus Isolates Associated with a Polymicrobial Biofilm. Antimicrob Agents Chemother. 2007 Jan; 51(1): 231–238. **7.** Ensminger, P., Counter, F., Thomas, L., Lebbehuse, P. Susceptibility, resistance development, and synergy of antimicrobial combinations against Clostridium difficile. Current Microbiology. 1982; 7: 59-62. **8.** Poilane, I., Bert, F., Cruaud, P., Nicolas-Chanoine, MH., Collignon, A. Interest of the disk diffusion method for screening Clostridium difficile isolates with decreased susceptibility to antibiotics. Pathologie Biologie (Paris). 2007; 55(8-9): 429-33. **9.** Cattoir, V., Ould-Hocine, ZF., Legrand, P. Antimicrobial susceptibility of Clostridium difficile clinical isolates collected from 2001 to 2007 in a French university hospital. Pathologie Biologie (Paris). 2008; 56(7-8): 407-11. **10.** Brazier, JS., Levett, PN., Stannard, AJ., Phillips, KD., Willis, AT. Antibiotic susceptibility of clinical isolates of clostridia. Journal of Antimicrobial Chemotherapy. 1985; 15(2): 181-5.

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Editorial

I would like to welcome everyone to the February edition of *Microbiology Today*, the first issue of 2017 and my first as Editor. I have enjoyed reading *Microbiology Today* over the years and always appreciated the wonderful diversity of topics it brings to its audience. I hope that we will continue to bring you varied and interesting articles to read. In that context I would like to say a huge thank-you to Laura Bowater and the *Microbiology Today* editorial team for all their help and advice during the handover of the editorship.

Whole Picture

In the February issue we are taking a look at some of the many issues that surround halting epidemics. While epidemics are a problem in many parts of the world, they can often remain a relatively low-profile topic. More recently, however, the devastation that epidemics can cause when not monitored and contained successfully has been brought into sharp focus. The consequences of high-profile epidemics like Ebola and Zika have been the subject of intense global media attention.

The first article in this edition looks at how the accelerated use of technology can be used to reduce the impact of epidemics like these. This first-hand account, by Nicholas Loman, describes how the use of real-time data in an epidemic situation influenced the course of that epidemic. He recounts how real-time sequencing of Ebola genomes from newly diagnosed cases helped to pinpoint the likely source of those cases. He also outlines some of the challenges that need addressing to ensure that technology like this can be implemented in a timely manner for maximum effect when these health threats do occur.

Nicola Stonehouse and Oluwapelumi Adeyemi have written the second article addressing the question, 'what are the prospects for the eradication of polio?' They describe how this disease impacts on health around the world and outlines the challenges that are currently impeding global vaccination, including the limitations of current vaccines. They highlight the important research that is underway, investigating the possibilities of alternative vaccination strategies. The aim of this research is to develop a safe and effective vaccine, which in combination with a global immunisation plan could help us move towards a polio-free world.

The next article, written by Kate Baker, helps to clarify what it is that makes a disease endemic or epidemic, using shigellosis as an example. This piece summarises the important role that various factors such as host and environment can have in determining whether a disease becomes either endemic or epidemic. It also highlights how, due to the complex interactions between influencing factors, even a small shift in one of them can alter the balance of disease and so change its course.

Some diseases have a higher profile than others, but despite the severity of its symptoms and potentially high fatality rate, leishmaniasis remains a neglected disease in India and the Middle East. Lee Haines and Geraldine Foster from the Liverpool School of Tropical Medicine discuss the transmission, diagnosis, treatment and current ideas for control of this disease. Stephen Baker gives an overview of the impact of zoonotic infections on public health. He shares first-hand experiences that demonstrate some of the problems associated with predicting the likely emergence and transmission patterns of emerging infectious diseases.

Finally, Michael Baron has written a Comment article on the eradication of rinderpest. He describes how it was possible to achieve the eradication of this disease using a combination of surveillance, diagnostics, education and vaccines. He also considers whether it could be possible to repeat this success to achieve the eradication of measles.

It is clear that epidemics have had a huge impact on public health throughout history, and that it is not always easy to predict where and when these outbreaks might occur. However, this edition demonstrates how developing technology and research, combined with education and surveillance, might go some way to addressing the challenges that epidemics bring.

Rowena Jenkins
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Contents

Microbiology
TODAY

Articles

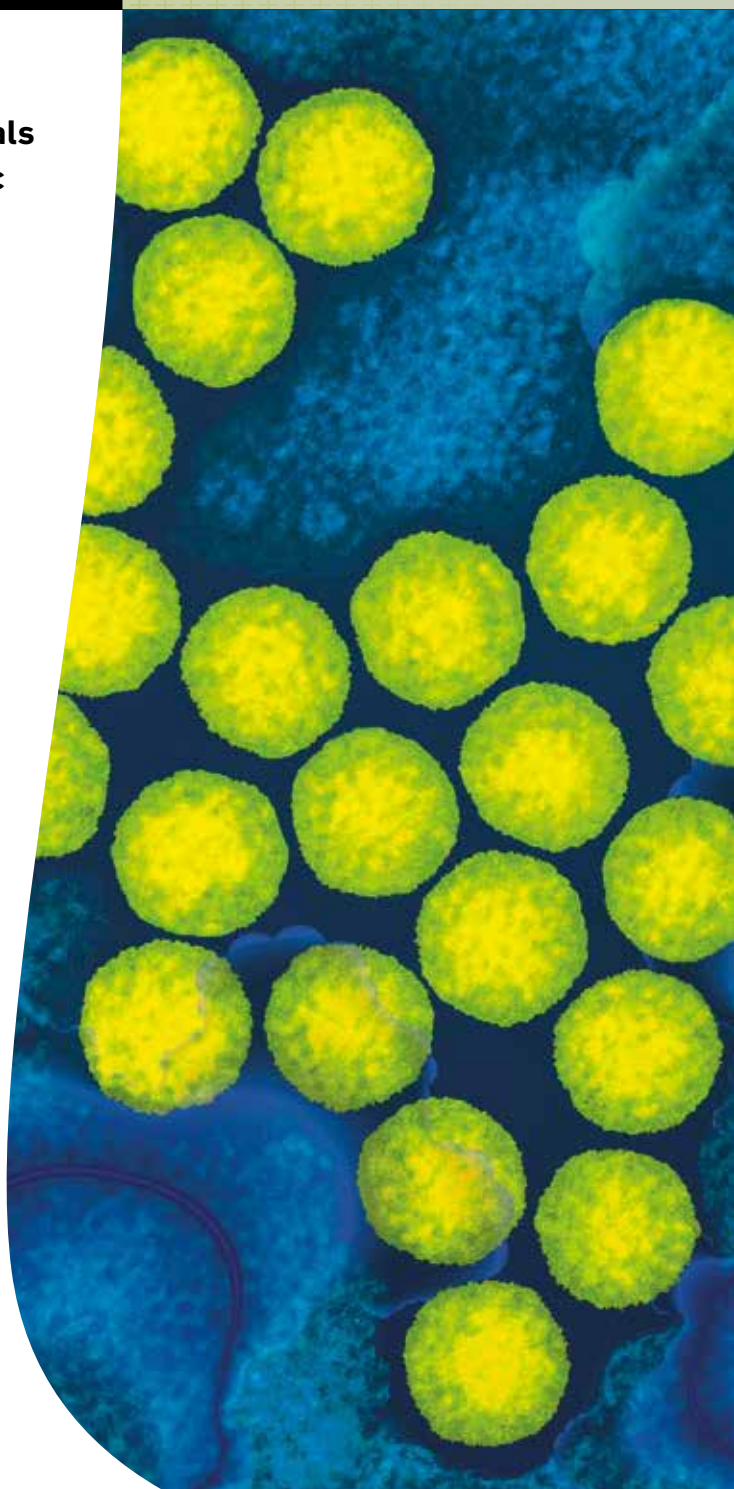
10 **Accelerated clinical and technology trials in response to the Ebola virus epidemic**
Nicholas Loman
A first-hand account of the response to the recent Ebola epidemic in Africa.

14 **Polio – what are the prospects for eradication?**
Oluwapelumi Adeyemi & Nicola Stonehouse
Approaches to eradicate poliomyelitis.

18 **How do epidemics become endemic? Lessons from shigellosis in men who have sex with men**
Kate Baker
Factors that facilitate the transition of disease and how it can persist in populations.

22 **Spotlight on leishmaniasis in India and the Middle East**
Lee Haines & Geraldine Foster
The types of leishmaniasis and measures to eliminate its impact.

26 **Emerging infectious diseases in Asia**
Stephen Baker
Preventing the emergence and spread of infectious diseases in Southeast Asia.



44:1 February 2017

Features

9 **Publish with the Microbiology Society**
Have a great experience and support our work.

36 **Publishing**
A roundup from the Publishing team.

38 **Early Career Microbiologists' Forum Update**
New Undergraduate Representative and preparing for Edinburgh.

39 **Outreach** – Big Biology Day and New Scientist Live
A review of public engagement events.

40 **Membership Q&A**
Marilia Costa tells us about her life and career.

41 **Improving the development and deployment of rapid diagnostic tests in low- and middle-income countries**
A summary of a one-day workshop.

42 **Schoolzone** – Teaching antimicrobial resistance in schools
Educating and informing about antimicrobial resistance.

44 **Policy** – Global action on antimicrobial resistance
The need for a One Health approach.

45 **Latest from the Society**
An update on what you may have missed.

47 **Comment** – Why don't we do this more often?
Michael D. Baron
What we can learn from the eradication of rinderpest.

Regulars

1 **Editorial**

4 **Council 2017**

5 **From the President**

6 **From the Chief Executive**

7 **News**

30 **Annual Conference**

34 **Focused Meetings**

46 **Reviews**

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Medical personnel being trained in the proper protocols for Ebola virus prevention. CDC/Nahid Bhadelia, M.D./Science Photo Library

MICROBIOLOGY SOCIETY

Council 2017

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From the President

This issue of *Microbiology Today* is packed with good things to whet the appetite for more fascinating microbiology in 2017. Dipping into the issue you will see that the main focus has generated a series of articles that deal with medical microbiology, from fundamental research in virology and bacteriology to clinical trial work on antimicrobials to public health issues.

We know that these types of articles are really appreciated by our members and by those who are looking for up-to-date reviews for teaching purposes – so we thank Nicola Stonehouse, Oluwapelumi Adeyemi, Nicholas Loman, Kate Baker, Lee Haines, Geraldine Foster, Stephen Baker and Michael Baron for their excellent contributions.

It's not many weeks now until the Society hosts our Annual Conference in Edinburgh. We had a record number of abstract submissions this year and the programme is looking excellent – you can find further information about the event in this issue of *Microbiology Today*. We are planning to make this Conference a festival of virology, bacteriology and eukaryotic microbiology, as well as a meeting with a lot of networking opportunities and social events. The structure of our meetings is increasingly informed by accurate information about what our members want and like, and the information that you provide through formal solicited feedback, via our social media sites or simply by speaking to Society staff and Council members, is highly valued. Our main Conference is of course not the only forum and watering hole for microbiological research that we organise and you can also read in this issue about the series of Focused Meetings that are planned for 2017.

Recent figures about our membership are encouraging with our membership numbers increasing over the last two years, and we aim to do more to support you and your work. As part of our commitment to supporting our members please read the article in this issue by Rebecca Hall, representing our newly established Early Career Microbiologists' Forum – which is now into its stride and is already shaping the Society's future vision and the day-to-day business of things that get discussed at Council.

This year, we will be working hard on the development of a new five-year strategic plan for the Society that will come into play next year. That plan will demonstrate our ambitions and determination to support microbiology, and shows that we are an organisation that provides both real benefits for our members and a strong voice for our discipline expressed through our publications and policy work. This edition of *Microbiology Today* also contains information on teaching antimicrobial resistance (AMR) in our education-focused article, Schoolzone, and a policy update on AMR reflecting a busy time for staff working in these areas.

2017 will see the Society producing a major piece of work: our Microbiome Policy Report. Our Microbiome Expert Working Group has recently met to consider the outputs from last year's stakeholder workshops, and will be working with Society staff on an accessible, evidence-based report that will cover human, animal and environmental microbiomes.

Finally, a happy anniversary to *Journal of General Virology*, which is celebrating its 50th year and to *Microbial Genomics*, which is celebrating the completion of its second volume and first full calendar year. We are proud of the full portfolio of journals that the Society publishes and their successes are important since our publishing activities are the major source of income for everything else we do.

Neil Gow
President
president@microbiologysociety.org

From the Chief Executive

During 2017, the Microbiology Society will need to replace its existing strategy, which has served us well for the past five years, but which will soon expire. As we do so, we will not focus on producing a document full of jargon that we bury deep on the website where nobody reads it. Instead, we want to capture the ambition, energy and enthusiasm that you have, as members of the Society, for the diverse and beautiful range of microbes that you study, and for the ways in which you can develop your science, apply it to real world challenges, and communicate about it to specialist and non-specialist audiences.

Over the period of the current five-year strategy, you will have seen some impressive developments at the Society. A new journal, *Microbial Genomics*, which is attracting first-rate science and is already indexed on Medline and PubMed. Policy work that is attracting the attention of politicians from the United Nations to national funding agencies. The biggest Annual Conference ever, as well as a whole host of Focused Meetings and Society-Supported Conferences covering every aspect of microbiology. New grants and resources to support your careers, and an Early Career Microbiologists' Forum to ensure that our efforts are directed towards furthering your careers. And a profile outside the discipline which means that we get a million hits a year across our website and other digital platforms.

At the same time, there have been many changes to the way the Society's staff work, and these may have been less obvious to you. We moved the office to Charles Darwin House, where we share our facilities with other like-minded societies. We have changed all sorts of things about our financial processes and HR policies, which you as members will not notice but which make it easier for us to spend more of our time supporting your interests. And we have put in place all sorts of mechanisms for making sure that Council, Committees, Divisions and the staff are collectively focusing on the things that matter to the membership.

So as we look to build a strategy for the next five years, we are in an extremely strong place to think really ambitiously about where your Society goes next. The Society's vision is *A world in which the science of microbiology provides maximum benefit to society*. If you watch the news or read the BBC website you will see that every day, there are stories about emerging diseases, new techniques, novel treatments and fresh discoveries that show just how much interest there is in microbiology and just how many medical, environmental, economic and other advantages we can deliver to the public through our subject.

So as we embark on refreshing the Society's strategy for the next five years, I am keen to speak to you about your ambitions for the organisation. I want to hear about what you think will be the focus of the next few years, where you think the staff should be directing our efforts, and what you want us to achieve together. We can have a big impact through a combination of the Society's resources, the unique depth and breadth of your microbiological knowledge, and the complementary skills of the staff. One of the great strengths of the Microbiology Society is its friendly, supportive and collaborative nature, meaning that every member – from undergraduate to Nobel laureate – can feel comfortable contributing to that endeavour.

So please let me know what you want the Society to accomplish in the next five years – and think big. The scale of the opportunity is huge and it is matched by the dedication of the staff, and the enthusiasm of Council, the Committees and Divisions. What we choose to do collectively for the next few years is limited only by our imaginations, so please do not be shy. Ring me, email me, invite me to come to your lab, and tell me where you want us to go together and what you want us to achieve.

Peter Cotgreave
Chief Executive
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News

Antibiotics Unearthed applications are open

After two successful years of running our citizen science project, Antibiotics Unearthed, we would like to invite members to apply for the 2017 programme. Applications are now open to run either the Undergraduate Programme, the School Partnership, or both! There is a broad scope to how the programme can fit into your teaching course structure – it could be as an additional afterschool programme, embedded into the curriculum, or anything in between. A profile of a teacher who has carried out the programme for the past two years can be found in the Schoolzone section of this issue (page 42). Further details about the programmes and how to apply can be found at **www.microbiologysociety.org/antibioticsunearthed**.

Microbiome Research Stakeholder Workshops

Last autumn, the Society's Policy team held five successful Microbiome Research Stakeholder Workshops across the UK and Ireland. The multidisciplinary workshops collectively connected around 160 stakeholders, including scientists, representatives from industry, and government departments and agencies. Participants discussed potential opportunities of exploring and exploiting microbiomes in humans, animals, plants and the environment. Also covered were the scientific, regulatory and public issues that need to be addressed to deliver on these opportunities. The outputs from these meetings are helping to inform the development of a report for policy audiences about microbiome research and innovation, led by our Microbiome Expert Working Group. For more information about the project, visit our website (**www.microbiologysociety.org/policy**) or contact our Policy Officer (**policy@microbiologysociety.org**).

2017 Society events

This year the Society is organising a variety of Focused Meetings, with topics ranging from agricultural and food security to the importance of a One Health approach. Our Annual Conference is taking place in Edinburgh in only two months' time, although there is still time to register. For more information on our events for the year, please see pages 30–34.

Record number of abstract submissions for Annual Conference 2017

Receiving over 600 abstracts for the Annual Conference last year was a great achievement, but the Microbiology Society is delighted to announce that there was a record number of over 900 abstracts submitted for our 2017 Conference. Thank you to everyone who submitted their work, and congratulations to those who were accepted.

If your research was accepted, why not read our 'how-to' guides on how to give poster (**http://microb.io/1W33aPd**) and oral presentations (**http://microb.io/1OfCNmc**)? Both can also be viewed on the 'Abstracts' tab of the Annual Conference 2017 web page (**www.microbiologysociety.org/annualconference**).

More members at the Society

We've good news – Society membership rose 15% in 2016 to 4,500 members. Most new members join as a result of a recommendation or referral from current members, so a large part of this growth can be directly attributed to you. A huge thank-you for helping to spread the word among your colleagues, students and friends – it clearly works!

And don't forget, we have resources on the website to help you tell others about the Society – posters for the noticeboard, slides to drop into a PowerPoint presentation, and literature explaining our grants offerings.

If you have any suggestions or requests for additional support, we would be delighted to hear from you. Please email Paul Easton, Head of Membership Services, at **p.easton@microbiologysociety.org**.

Microbiology Society journals

2017 brings plenty of news to share from our publishing arm. The Society's *Journal for General Virology* turns 50 years old this year, and we are pleased to welcome two new Co-Editors-in-Chief to *Journal of Medical Microbiology*. Two of our journals are also changing their article types, and our newest journal, *Microbial Genomics*, has partnered with Microreact – a free data visualisation tool. Find out more on pages 36–37.

Do you have what it takes to be a Society Champion?

If you're passionate about microbiology and enjoy sharing this passion with friends and colleagues, why not consider becoming a Society Champion? Champions help us spread the word in a variety of ways, and in return receive Society support to extend and deepen their relationship with us. If you're serious about microbiology and want to do that little bit more for the Society, we'd love to hear from you. Find out more by contacting Paul Easton, Head of Membership Services (**p.easton@microbiologysociety.org**).

Deaths

The Society is sad to announce the death of **Professor Sir Patrick Sissons**, who joined the Society in 1982.

Please contact **mtoday@microbiologysociety.org** if you wish to notify the Society of the death of a member whose details can be included in this section.

Grant deadlines

Date	Grant
1 March 2017	Travel Grants – for eligible members wishing to present at a conference or attend a short course between 1 April and 30 June 2017.
31 March 2017	ECM Forum Event Fund – for ECM members wishing to host a local event from 1 May onwards.
1 April 2017	Research Visit Grants – for eligible members wishing to visit a collaborator from 1 June onwards.
	Education and Outreach Grants – for members wishing to conduct a microbiology teaching, outreach or public engagement activity from 1 June onwards.
	International Development Fund – for eligible members wishing to contribute to microbiology development activities in low-income economy countries from 1 June onwards.
3 May 2017	Society Conference Grants – for eligible members wishing to attend the 33rd International Symposium on Yeasts (ISSY33) in Cork, Ireland.

Antibiotics Unearthed poster session at Annual Conference

This year's Annual Conference will host a poster session dedicated to our 2016 Antibiotics Unearthed School Partnerships and Undergraduate Programmes, taking place on Monday 3 April. Accompanying their posters will be some of the secondary school students and undergraduates involved in last year's programmes. Please give them a warm welcome as for some of them, especially the school students, this will be their first taste of an international science conference.

Contributions and feedback

The Society welcomes contributions and feedback from members. Please contact **mtoday@microbiologysociety.org** with your ideas.

Benjamin Thompson
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Publish with the Microbiology Society

Get a great publishing experience and help support the important work that we do.

Researchers working in microbiology today have a wider range of publishing options than ever before in the field's history. Publication of research is still the cornerstone of most microbiologists' careers, but choosing the right journal can be a minefield. New journals are seemingly launched every month, and span from the very niche to the broad 'mega' journal. Authors are faced with a dizzying range of options and pricing, and with all this choice it can be hard to work out the best place to send your research. It has become increasingly important to authors to know that they're publishing in a reputable journal, with good publishing standards and values.

We would like to strongly encourage our members to consider submitting their next article to one of the Microbiology Society's six peer-reviewed journals. The Society has been publishing research since 1947, and our journals are widely recognised as established, high-quality publications in the field. Whether your paper sits within microbial ecology, clinical microbiology, virology, or an emerging field like biotech or genomics, it should be suitable for one of our journals. It is free to publish in the journals (unless you choose our paid, gold open access option, OpenMicrobiology, or publish in one of our two fully gold open access journals), and we have fast turnaround times with high production standards. We also have a global readership – our journals are subscribed to by research institutions around the world and read by the international microbiology community.

Unlike commercial publishers (who publish the majority of journals in microbiology), we reinvest all profits from our publishing enterprise back into microbiology through the work that the Society does.

This includes funding our grants, putting on our scientific meetings, and supporting our education and policy outreach programmes. Journal revenues represent around 90% of the Society's income – they are essential if we are to continue our work and deliver our mission of advancing the understanding and impact of microbiology by connecting and empowering communities worldwide.

81% of authors stated that they would submit to the journal again, and would recommend publishing with the Microbiology Society to a friend or colleague.

If you read the author survey report in the last issue of *Microbiology Today*, you'll have seen that our journals offer a great publishing experience for authors. When asked, 83% of the authors who submitted to our journals within the last two years reported that they found the submission process either 'excellent' or 'very good'.

Publishing with the Society also provides extensive opportunities for collaboration, sharing of research and dissemination to the microbiology community. Our Communications team frequently interviews our authors and features their research in news articles, podcasts and videos. Visit our YouTube channel now to watch a film with *Journal of General Virology* author Dr Derek Gatherer on the spread of the Zika virus (**https://youtu.be/Iz0Weondbbo**).

If you're heading to the Annual Conference this year, be sure to attend the workshop on how to write a manuscript for submission, where Editors and publishing staff from our journals will be on hand to offer guidance on the publishing process.

The six journals published by the Microbiology Society are *Microbiology*, *Journal of General Virology*, *Journal of Medical Microbiology*, *JMM Case Reports*, *Microbial Genomics* and *International Journal of Systematic and Evolutionary Microbiology*. For more information about the journals we publish, and how you can submit your article, please visit **microbiologyresearch.org**. If you'd like to ask us anything at all about publishing with the Society, or get any general advice about publishing research, please get in touch at **editorial@microbiologysociety.org**.

Simon Hagan
Marketing Manager

Accelerated clinical and technology trials in response to the Ebola virus epidemic

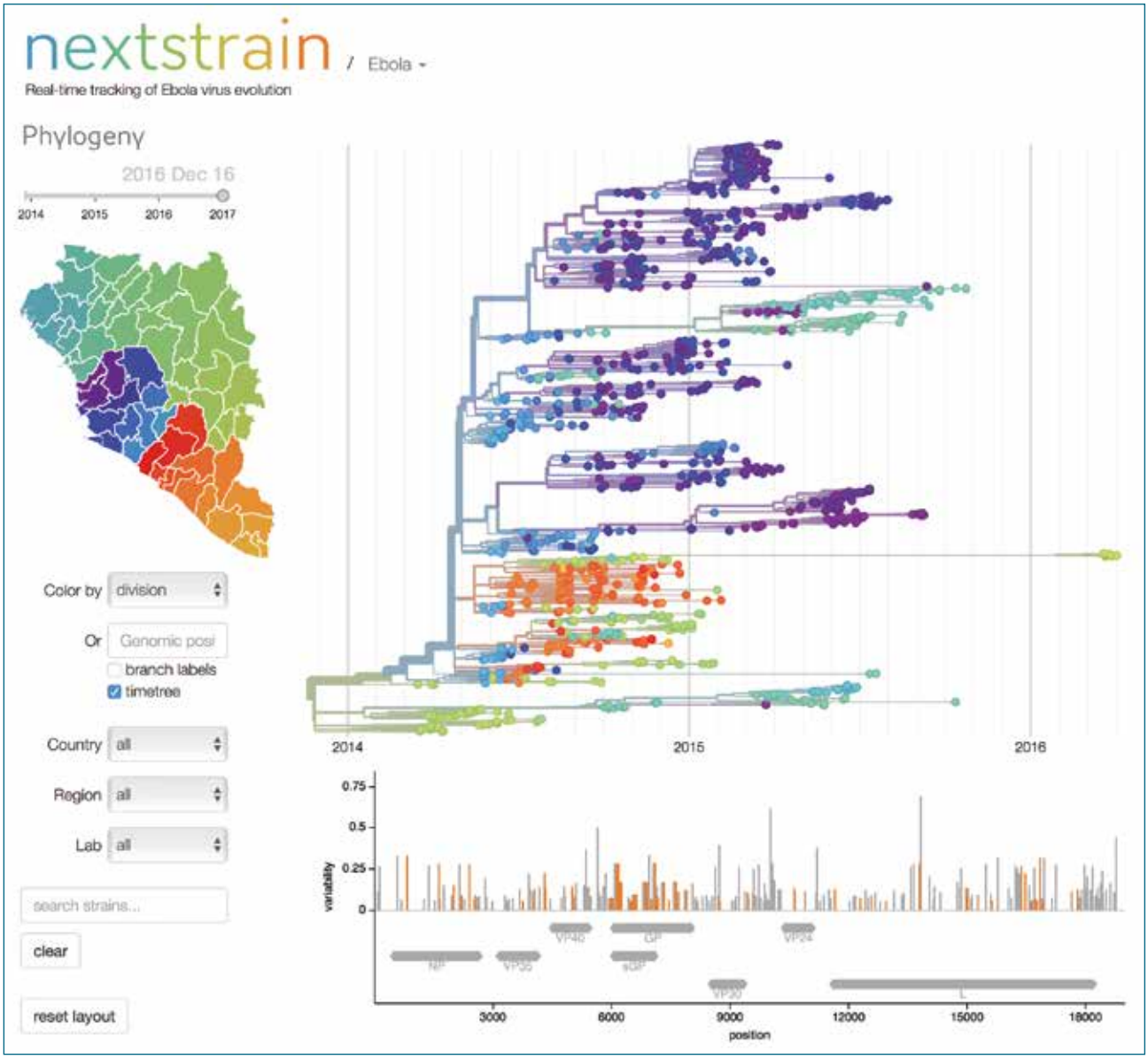
In April 2015, Josh Quick boarded an Air France flight to Conakry in Guinea. He took with him some very special luggage: all the equipment and reagents required to establish a genome sequencing laboratory in the field. Our idea was that if we could sequence Ebola virus genomes from newly diagnosed cases quickly enough then this information could provide vital information to guide the response to this tragic epidemic, which had already claimed over 10,000 lives.

Genome sequences of rapidly evolving viruses like Ebola turn out to be a rich source of information. Because the process of viral copying is error-prone, mutations in the genome are frequently introduced. We observed that Ebola, which has a 19,000-nucleotide long genome, was evolving at a rate of approximately two mutations each month. When compared with other genomes from the epidemic, clusters or lineages emerge. The clusters or lineages can highlight key parts of the DNA to help identify the groups of virus circulating in the population.

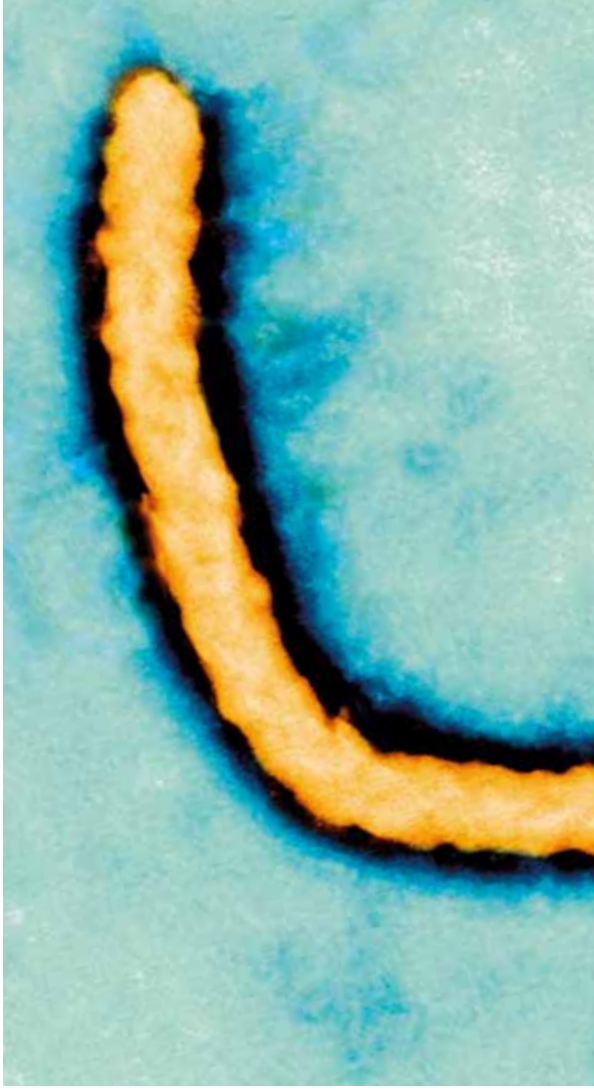
Nicholas Loman

Josh, working with Miles Carroll from Public Health England, set up sequencing rapidly and sequence data started flowing back to the University of Birmingham for analysis. To do this work we used a new handheld genome sequencer from UK-based Oxford Nanopore Technologies. The sequencer, MinION, is a pocket-sized sequencer, and is powered off a regular laptop. Remarkably, this sequencer can read individual single molecules by monitoring the changes in electrical current produced when DNA blocks a tiny protein pore: 'nanopore' sequencing.

With just a handful of genomes we could already tell that at least two major lineages of Ebola were circulating in Guinea at the time: one branched off early in the outbreak and was the dominant type seen in Sierra Leone and Liberia. The other seemed to be mainly confined to Guinea.



A snapshot of the Ebola page from the 'nextstrain' website (ebola.nextstrain.org) built by Richard Neher and Trevor Bedford.



Even this broad-brush information has value for epidemiologists; the evolutionary path of viruses takes a mainly random trajectory. Two viruses that have very similar genomes must have shared a recent common host. For an epidemiologist this can be translated into simple information: patients infected with the same lineage may be in the same chain of transmission. And, crucially, a newly diagnosed patient who has a lineage 2 virus could not have been infected by a patient-carrying lineage 1.

We presented our work to the World Health Organization and the Guinean epidemic coordinators in the Ministry of Health. They were thrilled with the idea of having this information produced in real-time and invited us to continue sequencing cases until the epidemic was over. This work was done under the auspices of the European Mobile Laboratories, an EU-funded network of mobile laboratories that had been rapidly set up in Guinea and Sierra Leone to provide diagnostic support.

Next, we set up the first of our 'genome centres' – in Coyah, Guinea (two more were to follow, in Nongo and in Guéckédou). Sophie Duraffour, a virologist from the Bernhard-Nocht Institut, ran the sequencing facility, and rapidly trained local clinical scientists and visiting volunteers from Europe.

The teams of epidemiologists in Guinea enthusiastically received the results we generated, often within a few days of receiving a patient sample. A challenge we faced was explaining the results of phylogenetic analysis to epidemiologists not used to dealing with this type of information.

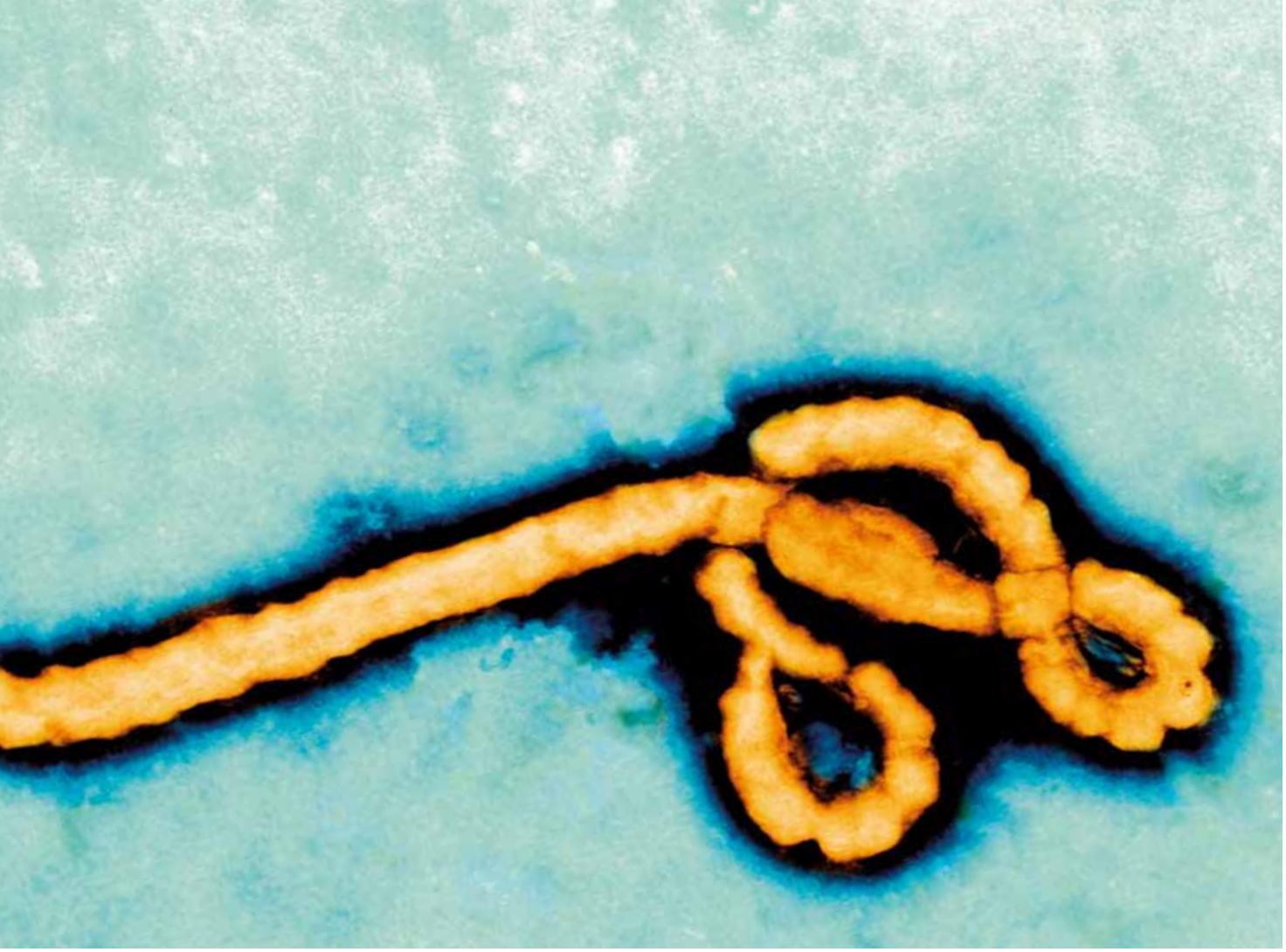
Many results were purely confirmatory, providing comfort that cases fell within known chains of transmission that were being tackled. Our data occasionally gave results that were unexpected. When combining our results with those generated by Ian Goodfellow – a virologist operating in Sierra Leone – we could show frequent examples of transmissions across the Guinean and Sierra Leone border. At the time this was not believed to be a significant factor, and resulted in tightening of border controls.

Towards the end of the epidemic, the sequencing data had their greatest value. As the gaps between new cases widened, new cases often did not have an obvious source. Often communities were unwilling to provide information about contacts. The phylogenetic information was often able to pinpoint the most likely source case directly.

The Ebola epidemic in West Africa from 2013 to 2016 was a remarkable event, but we now live in a time when remarkable events seem commonplace. Combinations of factors including climate change, disruption to the habitats of animal populations and increased human mobility mean that we can expect more outbreaks of emerging infectious diseases.

When the new reported cases of Ebola in Guinea seemed to stop in October 2015 everyone breathed a sigh of relief. Yet, six months later, new cases were reported. These cases were in Forested Guinea, close to the original epicentre. It was important to understand the source of these new cases: was it a new introduction from an animal population, perhaps bats? Or had Ebola been circulating undetected in humans in that region for the past six months?

In fact, we were rapidly able to prove a third option: the case was genetically



Transmission electron micrograph revealing some of the ultrastructural morphology displayed by an Ebola virus virion. Science Source/Science Photo Library

highly related to a case sequenced back in 2014. This individual had survived. The epidemiologists identified this same person as the likely source. On testing, he was positive for Ebola in his seminal fluid. Survivors with long-term Ebola infection had been known about before, including the famous case of Pauline Cafferkey who had several re-admissions to hospital with Ebola complications. Never though had there been a report of Ebola persistence for this long – 500 days – and resulting in a new cluster of cases.

The genomics and epidemiology in this case worked in perfect harmony – with only one source of information there would have been scope to doubt this result. Awareness that Ebola can persist this long and become infectious can improve the health information given to survivors. Biologically, the mechanism for this long-term persistence is not well understood and is a fruitful line of enquiry for future research.

The Ebola epidemic in West Africa from 2013 to 2016 was a remarkable event, but we now live in a time when remarkable events seem commonplace. Combinations of factors including climate change, disruption to the habitats of animal populations and increased human mobility mean that we can expect more outbreaks of emerging infectious diseases.

It took over a year from the first case to establish real-time genome sequencing in Ebola. Significant logistical challenges were encountered, including delays obtaining ethical clearance and budgets.

But genome sequencing – done rapidly and early enough – can provide vital information on where an outbreak has come from. We must improve our surveillance of emerging infectious diseases that might cause the next pandemic or epidemic so we are not caught out. In 2016 we are playing catch-up with Zika, which escaped our notice for many years until it exploded in the Americas.

Ebola survives undetected in animal populations and now in humans. We showed during the Ebola outbreak that routine sequencing was possible, and these tools should now be made routinely available for all pathogens anywhere in the world.

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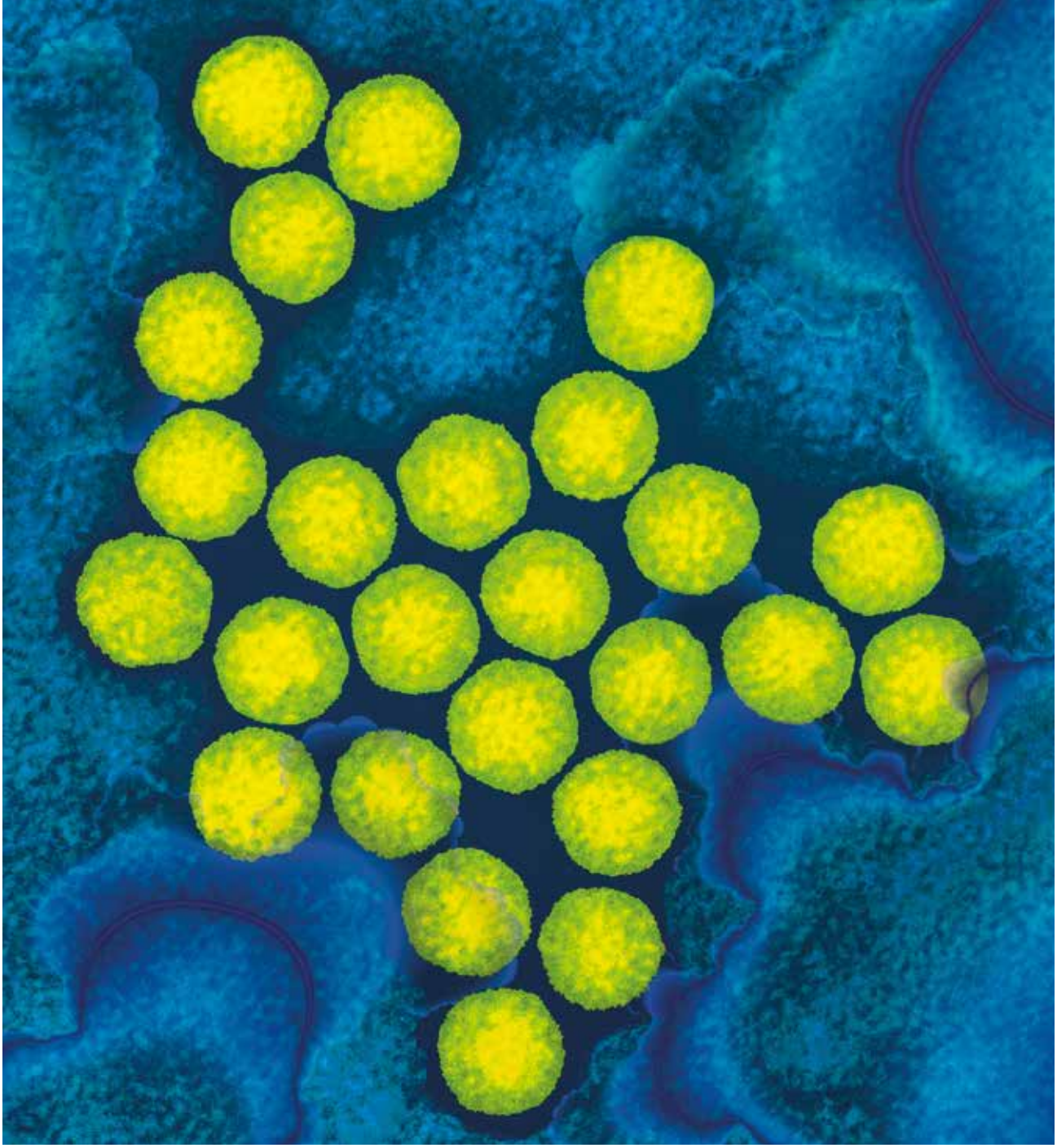


Polio – what are the prospects for eradication?

Oluwapelumi Adeyemi & Nicola Stonehouse

Coloured transmission electron micrograph of polio virus particles.
Dr Linda Stannard, UCT/Science Photo Library

Poliomyelitis can be a devastating disease. More commonly known as polio, it can lead to permanent paralysis in approximately 0.5% of cases. Furthermore, in up to 10% of paralytic polio cases, the disease will be fatal. Outbreaks of polio can therefore be crippling not just to individuals but to entire communities.

In 1988, the World Health Assembly initiated a programme to eradicate polio. Over the past three decades, the disease has disappeared from most of the world, but it remains endemic in Afghanistan, Pakistan and Nigeria (see Fig.1).

The causative agent is poliovirus (PV), a positive-sense RNA virus in the family *Picornaviridae* (Fig. 2). It is very easily transmitted and can be spread to vulnerable individuals by direct contact or via contaminated food or water. Worldwide immunisation against polio has been responsible for disease eradication from much of the world, and it is estimated by the World Health Organization (WHO) that since 1988, 5 million people have been saved from lifetime paralysis as a result. The oral polio vaccine (OPV) is composed of live, mutant virus that can infect and

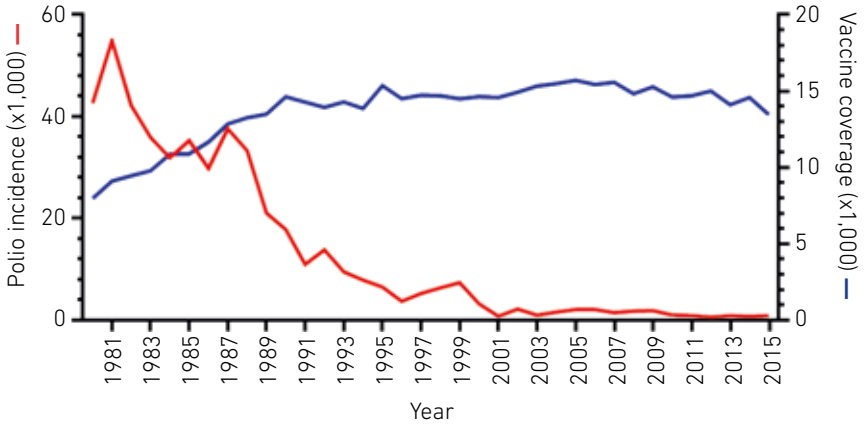


Fig. 1. Effect of immunisation (inactivated polio vaccine, IPV, and oral polio vaccine, OPV) on polio incidence worldwide. Red line, incidence of polio from 1980 to 2015; blue line, vaccine coverage (i.e. use of a combination of OPV and IPV) worldwide. Data was collected and collated through six WHO regions (Africa, the Americas, Eastern Mediterranean region, Europe, Southeast Asia and the Western Pacific region).
WHO vaccine-preventable diseases: monitoring system 2016 global summary **www.who.int/immunization/monitoring_surveillance/data/en**; *accessed 9 November 2016*

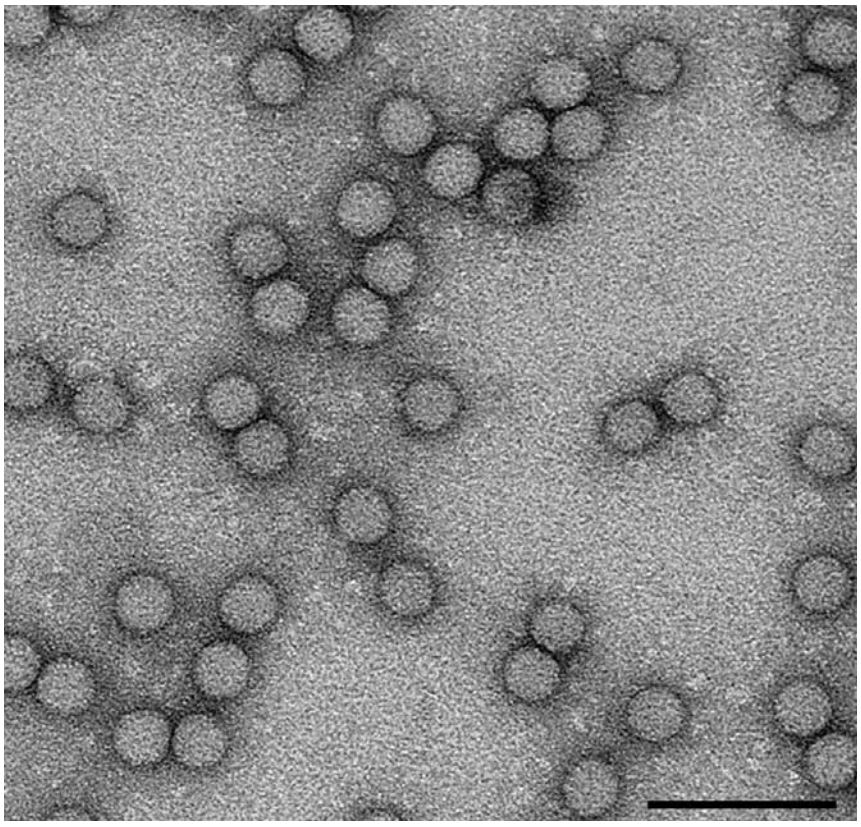


Fig. 2. Transmission electron micrograph of PV-1 viruses stained with uranyl acetate. Bar, 100 nm.
Anna Higgins, Sam Stephen & Clare Nicol, University of Leeds

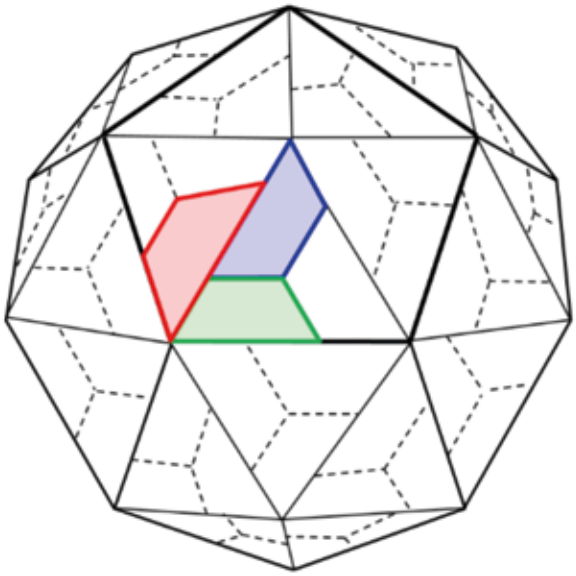
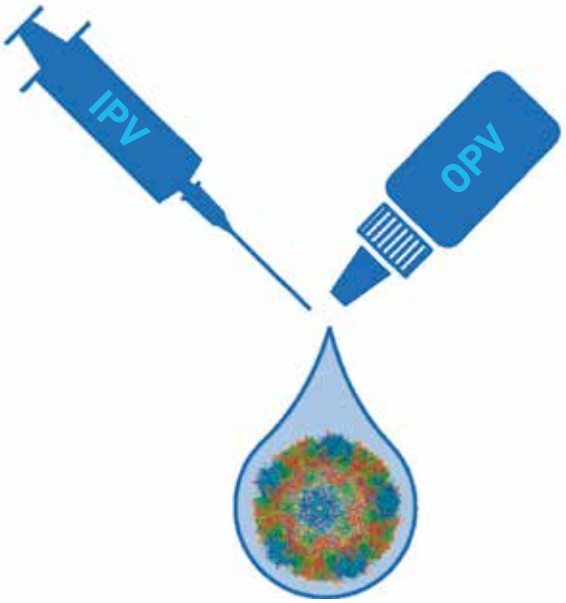


Fig. 3. Cartoon model of the PV capsid. A pentamer is outlined and VP1 (blue), VP2 (green), and VP3 (red) are highlighted. Virion maturation involves cleavage of VP0 into VP2 and VP4 (which is internal) (Jacobson & Baltimore, 1968). Redrawn by Oluwapelumi Adeyemi, University of Leeds

reproduce in the human host, but does not cause paralytic disease. It is both cheap to make and easy to administer by mouth in a sugar solution. The use of such oral administration can be undertaken by local volunteers who are not required to be medically trained. This approach allows for the large-scale immunisation that was necessary to eradicate disease in many countries, for example in the Philippines and India. Despite this success and the ongoing efforts of local volunteers, there are challenges that need to be overcome. These are mainly political and geographic. It can be extremely challenging to vaccinate in remote areas, and in some instances, vaccinators have been targeted by radical groups amidst regional conflicts. However, the Global Polio Eradication Initiative, which is led by national governments and supported by five partners (World Health Organization (WHO), Rotary, Centers for Disease Control and Prevention (CDC), United Nations International Children's Emergency Fund (UNICEF) and the Bill & Melinda Gates Foundation) is committed to continuing immunisation to create a polio-free world.

The OPV is being replaced in much of the world by an inactivated vaccine (IPV) – virus inactivated by treatment with formaldehyde, delivered by injection. The change to such a more expensive vaccine (in terms of both manufacture and delivery) is due to two problems associated with the OPV. The RNA-dependent RNA polymerase that is responsible for making copies of the PV genomic RNA is very error-prone. Therefore, the virus can mutate and/or recombine with circuiting picornaviruses. In rare cases, use of the OPV can therefore cause disease in vaccine recipients or their close contacts (1 in 2.7 million children receiving their first dose of OPV). Secondly, there is a small but important number of immune-deficient or immunocompromised people who are unable to clear the virus after vaccination and therefore persistently shed vaccine-derived virus for long periods of time after immunisation. These individuals would represent a potential source of infection if we were to stop vaccine use. The IPV is not a live virus and therefore does not present either of these risks. However, its manufacture does have considerable biosafety issues as large amounts of virus need to be produced prior to inactivation.



Current polio vaccine strategies. A crystalline reconstruction of a poliovirus particle (PDB.1ASJ) (Wien *et al.*, 1996) is super-imposed on the cartoon depiction of a liquid droplet emanating from a syringe or a vial which represent current IPV and OPV, respectively. Figure is not drawn to scale. Oluwapelumi Adeyemi

It is clear that we are getting closer to a world without polio, and over the past decade several countries have achieved polio-free status. However, it is also clear that even after wild-type virus is eliminated, we will still need to keep vaccinating for many years in order to

avoid outbreaks from vaccine-derived virus.

The WHO is actively involved in funding research into alternative vaccine strategies, which is complicated by there being three distinct PV serotypes. The University of Leeds heads a WHO-funded consortium which aims to develop virus-like particle (VLP) vaccines against polio. VLPs are particles assembled from the proteins that make up the coat, or capsid, of the virus. They contain no viral genomic material, and are therefore both safe to manufacture and to use, as illustrated by the successful human hepatitis B virus and papillomavirus VLP vaccines (Cervarix, Gardasil).

Empty capsids (protein capsids containing no RNA) are made during the normal PV growth cycle. However, these are antigenically unstable, because encapsidation of RNA is required to stabilise the antigenic structure of the particle – the final maturation cleavage step only occurs in the presence of RNA. The capsid proteins VP0, VP1 and VP3 are produced as part of a polyprotein from the P1 region of the genome. VP0 is cleaved into VP2 and VP4 upon RNA encapsidation (Fig. 3). This metastable nature of the PV empty capsid (which still contains VP0) results in a change to a non-native conformation, even at temperatures as low as 10 °C – therefore useless as a vaccine. Our approach is to incorporate stabilising mutations into the capsid and express the capsid proteins in a heterologous expression system such as yeast, insect or plant cells. The consortium has used a number of different approaches to arrive at stabilised capsids. These include structure-based design, reversion of temperature–sensitive mutations and using thermal stress to select more stable capsids. We have successfully developed stabilised particles, and some of these are more stable than the formaldehyde-inactivated IPV. The current challenge is to be able to make stabilised VLPs at high yield in our expression systems and translate these into a polio vaccine for the future.

It is clear that we are getting closer to a world without polio, and over the past decade several countries have achieved polio-free status. However, it is clear that even after wild-type virus is eliminated, we will still need to keep vaccinating for many years in order to avoid outbreaks from vaccine-derived virus.

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The WHO-funded VLP vaccine consortium includes:

- University of Leeds: Dave Rowlands, Nicola Stonehouse, Clare Nicol, Oluwapelumi Adeyemi, Lee Sherry
- University of Oxford: Dave Stuart, Liz Fry, Luigi de Colibus, Mohammed Bahar, Claudine Porta
- University of Reading: Ian Jones, Mai Uchida, Sinead Lyons
- The Pirbright Institute: Toby Tuthill, Joe Newman
- John Innes Centre: George Lomonossoff, Johana Marsian
- National Institute for Biological Standards and Control: Andrew Macadam, Phil Minor, Helen Fox, Sarah Knowlson
- Scientific Advisory Board: Jim Hogle, Ellie Ehrenfeld, Jeff Almond

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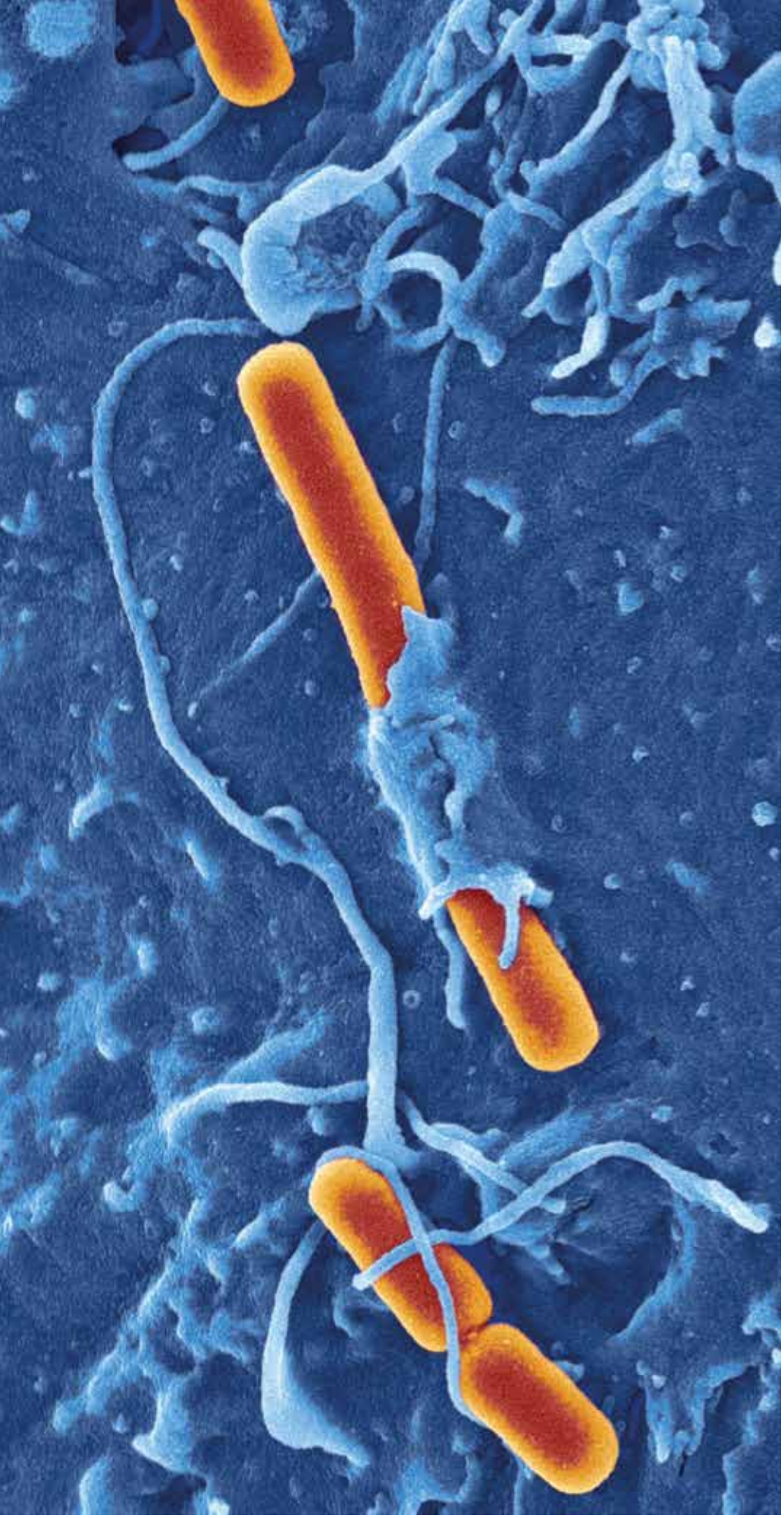
How do epidemics become endemic?

Lessons from shigellosis in men who have sex with men

Kate Baker

Understanding how epidemics become endemic is key to understanding how disease transitions and persists in populations.

I'll begin with some definitions. The words 'epidemic' and 'endemic' are epidemiological terms used to refer to levels of a disease, but both terms are specific for a particular host in a specified area/environment. An epidemic is an increase in disease levels above normal or 'background' levels, but because of the specifity of area, multiple cases of malaria would constitute an *epidemic* in the South of England, but the same number of cases would not be considered an epidemic in Malawi, where malaria is more common. In fact, malaria is *endemic* in Malawi, which means that there is continued transmission of the disease in the human population without further external input. The fundamental requirements for epidemic and endemic transmission are similar, and very simply defined. For propagated epidemics (i.e. those contagiously transmitted and not related to a single point-source, such as a contaminated well), diseased individuals must infect (on average) more than one other susceptible individual in the population (this is called the basic reproduction number, or R_0). For endemic transmission to ensue, R_0 must remain greater than one despite any factors that make it less likely for diseased individuals to spread the pathogen to susceptible individuals (e.g. consequential immunity in the population, a small population size, or effective treatment and/or quarantine of diseased individuals).



To conceptualise how changes in disease levels occur, it is helpful to think of the background level of disease resulting from a balance between the pathogen, host and environment.

Shigella flexneri invading embryonic stem cell.
David Goulding, Sanger Institute/Wellcome Images

To conceptualise how changes in disease levels occur, it is helpful to think of the background level of disease resulting from a balance between the pathogen, host and environment. Simple changes in any one of these factors can precipitate disease emergence (epidemics) (Fig. 1). For example, changes in environmental temperatures can increase disease levels by altering the geographic distribution of vector populations for insect-borne pathogens such as Zika virus; an increase in host population HIV prevalence can alter the immunological landscape of host populations such that the emergence of multiple diseases might occur; and pathogen adaptation can also facilitate emergence, such as the acquisition of

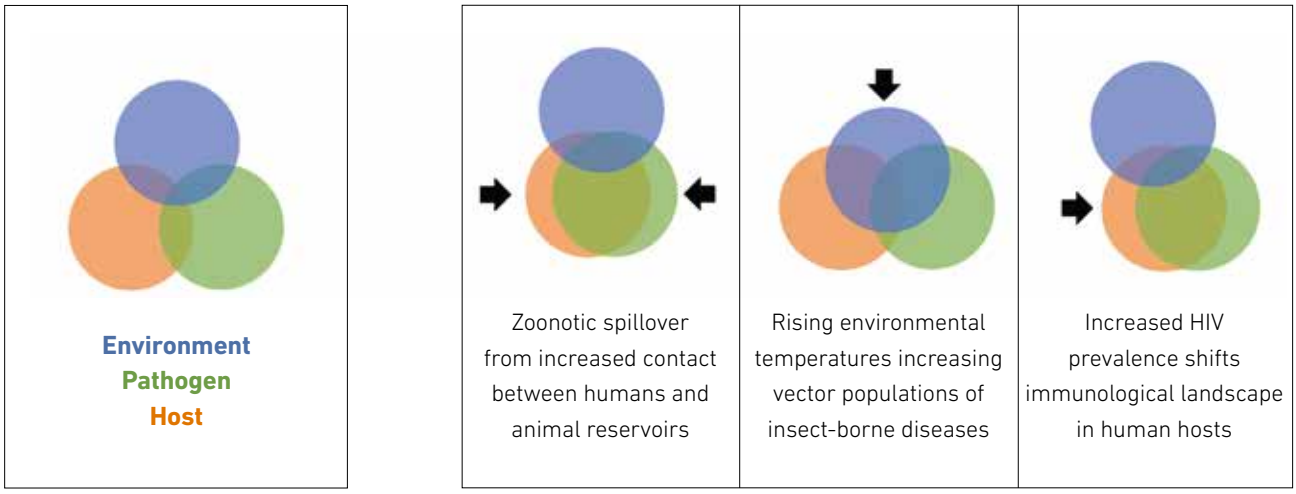


Fig. 1. Shifts in the interactions among a host and pathogen in an environment can give rise to epidemics. K. Baker

vitamin B5 synthesis machinery by the diarrhoeal pathogen *Campylobacter jejuni* aiding mammalian host infection. Although some simple shifts can result in epidemic emergence followed by endemic disease transmission, it is more common that subsequent endemic disease results from multiple changes in the balance among the three factors (host, pathogen and environment) in a complex interplay that evolves over the course of the initial emergence (Fig. 1).

To illustrate this fully, I will elaborate on a recent example of disease that has gone from being epidemic to endemic: shigellosis in men who have sex with men (MSM) in the UK. As background, shigellosis is a bacterial diarrhoeal disease common in low-income nations that has also been reported as a sexually-transmissible illness in MSM since 1974. Following that initial report, small-scale and apparently self-limiting epidemics of MSM-associated shigellosis have been reported sporadically in large cities around the globe and, within MSM, direct oro-anal contact and HIV infection are significant risk factors for infection. In the UK, epidemic levels of the diarrhoeal pathogen *Shigella flexneri* 3a associated with MSM were detected in 2009 and since then, the disease has transmitted endemically and intensified, with the emergence of two other types of *Shigella*: *S. flexneri* 2a and *Shigella sonnei*. Combining in-depth epidemiological information, including interview data from patients, and whole genome sequence analysis of *S. flexneri* 3a isolates from the outbreak and around the world provided insight on how shigellosis became endemic in this scenario (Fig. 2).

The first step in the emergence of shigellosis in the UK MSM population was the introduction of a novel *Shigella* strain to a transmission-facilitating environment. Phylogeographic analysis showed that the epidemic strain may have originated in Latin America and, within the UK, was largely restricted to London. This suggests that the sheer size of the London MSM network may have contributed to perpetuation of the epidemic, providing sufficient susceptible individuals to overcome any critical community size requirement for ongoing transmission, which is congruous with other reports of sexually-transmitted shigellosis epidemics arising in major population centres. In addition to its large size, the density of the transmission network may have also contributed. Interview data from shigellosis-affected patients revealed high numbers of sexual partners, often without the use of condoms and the frequent use of social networking applications, such as Grindr (released in 2009), to facilitate meeting partners for sexual contact. The recent coincident emergences of multiple other sexually transmitted infections (STIs), including gonorrhoea, chlamydial disease and syphilis, supports the notion that the suitability of the transmission network contributed to the emergence of shigellosis in the UK MSM population.

In addition to environmental factors, there were also host-specific factors that aided the endemic transmission of shigellosis among MSM in the UK. Patient interview data revealed common co-infection with HIV and sero-adaptive behaviours, including HIV-positive men actively seeking HIV-positive partners for condomless sex. Sero-adaptive behaviours have been increasing since the advent of Highly Active Anti-Retroviral Therapy (HAART), and consequential increased sexual contact among HIV-positive individuals may have led to a generalised increase in STI transmission, including shigellosis. This is supported by the co- or recent- infection with other epidemic STIs (i.e. gonorrhoea, chlamydial disease and syphilis) of HIV-positive shigellosis patients. In addition to this transmission-moderating effect of HIV therapy, the impact of HIV infection

itself on the course of shigellosis infection is unclear. There are some reports of chronic *Shigella* infection in HIV-positive individuals, and this, along with the potential for rapid reinfection, was supported by the recent genomic epidemiology study. Thus, increased transmission among HIV-positive hosts with the potential for chronic and/or re-infection (which would increase the duration of infectivity) further enhanced *Shigella* transmission.

The final contributing factor identified in the emergence of endemic shigellosis in the UK MSM population was pathogen adaptation. Whole genome sequence analysis of the MSM-associated strain of *S. flexneri* 3a revealed that lineages occurring later in the outbreak were resistant to the antibiotic azithromycin. Although the recommended antibiotic treatment for shigellosis is ciprofloxacin, the other STIs commonly reported in these patients (i.e. gonorrhoea, chlamydial disease, and syphilis) are often treated with azithromycin. The extent of antibiotic use in shigellosis-affected MSM was revealed in a German study, where 43% of patients had received antimicrobials in the six months prior to diagnosis. This creates a sustained selective pressure for *Shigella* circulating in the community to acquire azithromycin resistance, particularly given that chronic infection might overlap with treatment periods for comorbid STIs.

To summarise then, the emergence of MSM-associated *Shigella* in the UK is explained partly by the mere introduction of a new pathogen to a suitable environment and host population. That is, a technologically-enhanced, large, dense transmission network of potentially immunocompromised individuals in which shigellosis is one of multiple increasing STIs. However, unlike previously described shigellosis epidemics in MSM, this emergence was followed by sustained endemic transmission, which suggests that in addition to these host and environmental factors, pathogen adaptation played a key role. This example demonstrates how complex the factors can be that facilitate the transition of a disease from being epidemic to endemic, and the utility of monitoring for pathogen adaptation over the course of disease outbreaks.

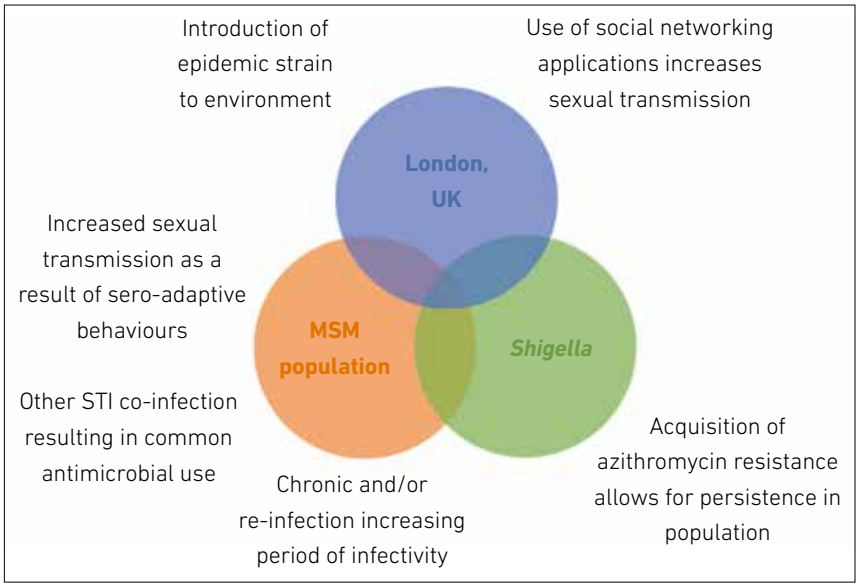


Fig. 2. Contributing factors that facilitated the emergence of endemically-transmitting shigellosis in the MSM population in the UK. K. Baker

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Spotlight on leishmaniasis in India and the Middle East

Leishmaniasis is an ancient parasitic disease spread by the bite of an infected female phlebotomine sand fly. This neglected disease, which predominantly affects the very poorest, can manifest as three distinct forms depending on the *Leishmania* species transmitted: visceral (internal organ damage), mucocutaneous (destruction to mucosal membranes in nose and mouth) and cutaneous (disfiguring skin ulcers). In this article, we briefly review the current status of leishmaniasis in India and the Middle East within the context of disease elimination.

Testing alpha-cypermethrin insecticide for vector control using Hudson compression pumps in Bihar State, India. Geraldine Foster

Lee Haines & Geraldine Foster

Visceral leishmaniasis (VL)

Apart from malaria, VL is the biggest parasitic disease killer in the world. The visceral form of the disease is the most severe, and in low-income countries the fatality rate can be as high as 100% within two years. Although VL is endemic to over 80 countries worldwide, more than 90% of the world's cases come from just six countries: India, Bangladesh, Nepal, South Sudan, Brazil and Ethiopia. Of these, nearly 80% of cases come from just one state in India: Bihar, one of the poorest states in a country where 224 million people live below the poverty line.

The name for VL comes from the migration of the parasites into the internal organs of the infected host (viscera = internal organs in anatomy). The Hindi name for VL, *kala azar*, comes from the words for 'black' and 'fever' and was named for the dark complexion that many sufferers develop. Other symptoms include prolonged, irregular fever; enlargement of the spleen and liver; and anaemia. When death occurs, it is often due to either haemorrhagic or infectious complications.

Disease transmission control

The elimination of VL is an important public health priority in the Indian subcontinent, and in 2005 the governments of India, Bangladesh and Nepal signed an international agreement which committed them to a partnership using shared methods to achieve elimination by 2015. The strategy so far with patients has been focused on improving early diagnosis and increasing access to treatment. From an insect control perspective, enhancing indoor residual spraying (IRS) of insecticides has helped decrease the population of *Phlebotomus argentipes* sand flies that transmit the disease. Unfortunately, the target of 2015 was missed. However, the programme to eliminate VL has shown great progress, with a 75% drop in the number of cases since 2005, when the programme was launched.

Early diagnosis

The diagnosis of VL in India has been greatly improved by the adoption of the rk39, a rapid diagnostic test that detects the presence of human antibodies produced in response to *Leishmania* infection. Prior to introducing the rk39, and in regions where supply of these tests is uncertain, the only method of diagnosis was through biopsy of

Training for insecticide spraying in Bihar State, India. Geraldine Foster

the spleen followed by microscopic examination of the tissue for the presence of parasites. This procedure requires facilities and expertise that are not frequently present in the rural areas where the majority of cases occur.

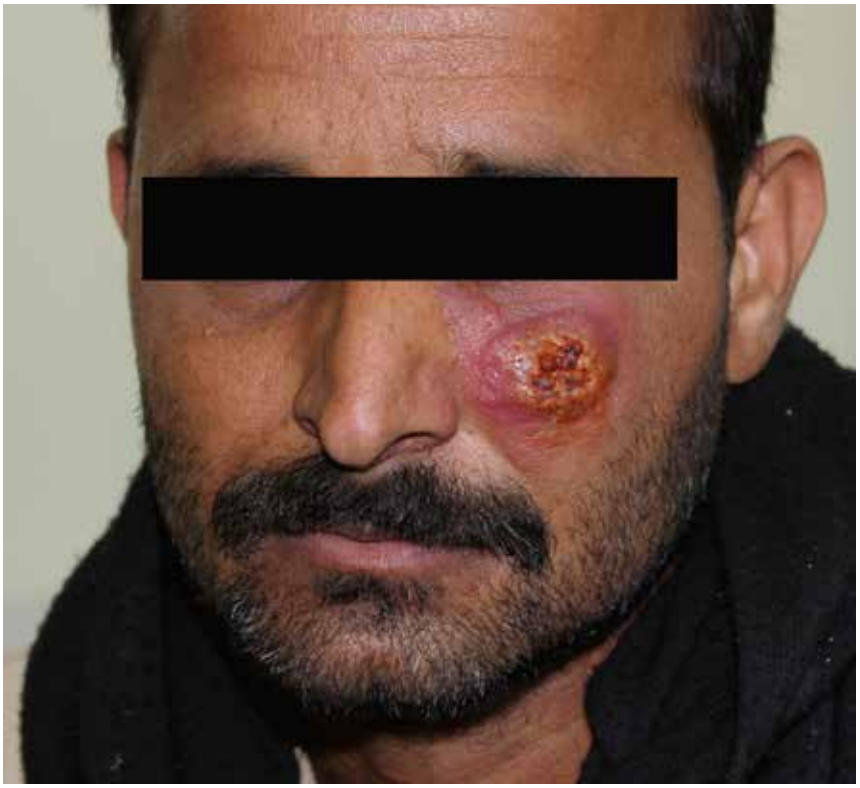
Treatment

Historically, treatment for VL in India was long and costly. Treatments using sodium stibogluconate (SSG; Pentostam®, GlaxoSmithKline) and amphotericin B required daily or alternate-day injections for up to 30 days. Additionally, both treatments have the potential to cause side effects such as rigors, fever, and liver, kidney or heart disease, which has been estimated at up to 85% for treatment with SSG and 98% for amphotericin B in India.

A newer treatment, miltefosine, can be taken orally and has a lower risk of toxicity, although patients are still required to travel to the local clinic to take the dose under supervision. Better yet is Ambisome™, a preparation of amphotericin B that causes fewer side effects than any other treatment option, but which is prohibitively costly. However, Gilead Sciences has recently announced provision of 380,000 vials of Ambisome™ over the next five years, improving treatment prospects for many patients.

Improving vector control

To reduce the sand fly populations, the Indian Government uses IRS, a vector control technique that sprays insecticide onto the interior walls of houses using pumps carried from house to house by spray operators. India has historically used DDT for its IRS, however, research performed in 2015 showed that the DDT was only active against sand fly populations for one month instead of the hoped-for six. This prompted the Government to change to using a different insecticide – alpha-cypermethrin – and to upgrade the pumps used for the spraying to more modern compression pumps. These advances are expected to achieve elimination in India by 2020.



Cutaneous leishmaniasis facial lesion. Waleed Al Salem

Cutaneous leishmaniasis

Cutaneous leishmaniasis (CL) is the most common form of leishmaniasis as it is prevalent in 98 countries, with more than 1.3 million cases reported annually. With the current political unrest in the Middle East, CL outbreaks are erupting where conflict has disrupted health care systems (including vector control programmes) and forced people to flee into disease endemic areas. Camps filled with displaced persons, military personnel and relief workers are particularly hard hit due to overcrowding, lack of housing infrastructures, and inadequate sanitation, which provide perfect breeding conditions for sand flies and rampant disease transmission.

Diagnosis

Cutaneous lesions can be complicated to diagnose as they can manifest as a range of other dermatological conditions (warts, bacterial abscesses, skin cancer, leprosy, etc.). Typically, patients suffer from painless, raised-edge ulcers that are slow to heal and often infected with secondary microbial infections. These lesions can appear months to years after the infectious sand fly bite and healing often produces unsightly

A child receiving SSG treatment in Pakistan. Nasir Ghafoor/MSF

scars. Those living with disfigurement, particularly women and girls, can experience extreme social stigmatisation that can permanently mar life quality with anxiety, depression, and decreased marriage potential. Microscopy and wound examination by specialised dermatologists are the most accessible means of diagnosing CL outside of lab-based assays. In resource-poor settings, where access to such highly trained personnel and microscopes (or even electricity) is limited, the development of new rapid diagnostic tests to not only confirm leishmaniasis, but also discern between the parasite species causing the infection, is needed. This latter point is very important as patient treatment responses vary considerably since *Leishmania* species can have different drug sensitivities. Serological (blood-based assays) testing can also provide diagnostic information, although discerning an active infection from a latent infection can be complicated.

Treatment

Although CL is often self-clearing, long-lasting lesions (can be years) produce significant scarring and it is possible that it can spread to the more invasive, mucocutaneous form if left untreated. Topical therapies include cryotherapy, thermotherapy (including burning) and surgical excision. As with VL treatment regimes, SSG is administered to patients with CL lesions that do not heal after initial antibiotic/antifungal treatment. Weeks of painful intralesional or systemic injections (sometimes several courses) produce high cure rates, but in resource-restricted settings, such treatments can be logistically difficult.

Media representation

Unfortunately, recent world media spotlights have falsely branded CL as a "flesh-eating disease" or "zombie disease". Images of disfigured patients with Gentian violet-stained facial lesions, combined with sensationalised journalism, have further heightened xenophobic sentiments and fear in host countries accepting refugees. It is worth emphasising that CL can only be transmitted via sand flies; patients need access to treatment, not a quarantine.

Leishmaniasis prevention

As there are no prophylactic drugs and promising vaccine candidates have yet to manifest into phase III clinical trials, prevention is the most effective way to reduce disease burden. In the poorest regions, this can only be achieved by removing sand fly and animal reservoir populations from human settlements; eliminating sand fly habitats; and implementing disease/entomological surveillance strategies so that insect control and public health interventions can effectively target those areas at highest risk.

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Further reading

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Emerging infectious diseases in Asia

Stephen Baker

I currently live in Vietnam, working at the Oxford University Clinical Research Unit, which is located in the Hospital for Tropical Diseases in Ho Chi Minh City. Vietnam, and more broadly Southeast Asia, is one of the most densely populated areas of the planet and presents some unique challenges for understanding how we prevent the emergence and spread of infectious diseases.

The king of the market. Fact & fiction films

Zoonotic diseases that pass from animal to human are an international public health problem regardless of location – being infected with *Campylobacter* from eating undercooked chicken in the UK is not uncommon, for example – but in lower-income countries the opportunities for such pathogens to enter the food chain are amplified.

In Vietnam, and across the region, humans have a very different way of interacting with animals being bred for food than would be familiar to those in the UK. If one were to travel to the Mekong Delta region (in the south of Vietnam) it would not be uncommon to see people who keep a large variety of farm animals in, or in close proximity to, their houses. Indeed, in rural areas many humans have daily contact with animals, such as water buffalo, that those of us in

Mr Ba, a backyard farmer in the Mekong delta, feeds his poultry. Truong Van Ba

the West would rarely experience in our lifetime. Furthermore, the practices and traditions that exist here provide ample opportunities for pathogens with zoonotic potential to infect humans. It comes as little surprise that in a country where raw pig blood and pig uterus are commonly consumed, the number one cause of bacterial meningitis is *Streptococcus suis*, a colonising bacterium of pigs.

The major problem of researching emerging infections is predicting how they arise and how we respond to them once they do. For example, we have been working with other groups in and out of Vietnam to study the trade in rice field rats (*Rattus argentiventer*), which are a culinary delicacy in parts of the Mekong Delta region. The route from rice field to restaurant begins with rat catchers who cross the border from Vietnam into Cambodia in the early hours of the morning. They walk across the rice fields that scatter the border and aim to catch the rats, which are caged and brought back to their houses. The live, caged rats are transferred to a large central market for dawn and are butchered, often alongside other animals, before being sold by the kilo to restaurants or individuals. This gives an idea of the opportunities that exist for an infectious disease to be transported across borders and around countries – within a few hours these rats will have travelled over 100 kilometres and come into contact with multiple people.

Given the complexity of zoonotic disease emergence and transmission, it is very rare that an outbreak can be traced back to the first identified human or animal case – known as the 'index case' and this remains a substantial challenge. A lack of effective health and surveillance infrastructures in many lower income countries compounds this issue, as we are wholly reliant on individuals entering the healthcare system and getting diagnosed, which seldom happens.

The ideal scenario is that we can identify new pathogens with zoonotic potential in animals prior to them spilling over into humans. However, if we cannot achieve this we need to be aware of their existence and be able to respond by treating people effectively once they are infected. This means rapidly identifying patients with a particular infection, assessing the severity of their condition and diagnosing the agent. Therefore, having sentinel hospitals with well-trained clinical staff, good diagnostics and microbiology facilities

There is no 'one-size-fits-all' approach for best studying how pathogens emerge and how we can prevent them.

is the best opportunity we are going to have to detect diseases.

The most recent example of this is a case of *Trypanosoma evansi* infection – a protozoan disease of animals and, rarely, humans – that we identified in a woman attending our hospital with an atypical disease presentation. Ultimately, we were able to trace this infection back to her cutting herself when butchering a buffalo in her family house during New Year celebrations – this was the first reported human case of *T. evansi* in Southeast Asia. Our ability to interact with animal health authorities permitted access to sampling bovines in the proximity of the patient's house. We found a very high prevalence of the parasite in the blood of cattle and buffalo local to where the woman lived, highlighting a new zoonotic infection in the region and likely a sustained risk. A further example is an ongoing outbreak of brucellosis, something that had never been observed or reported in the south of Vietnam in the 25 years that our research unit has been studying infection. We have had 10 cases in less than six months, all from a province close to Ho Chi Minh City where backyard farming is common. We are currently investigating the zoonotic exposure in these cases and working with local authorities to control the spread.

Diagnostic information has also been vital in data we published detailing an outbreak of fluoroquinolone-resistant *Shigella sonnei*. The reason we found this organism was that one of my clinical colleagues was culturing organisms from children with severe diarrhoeal disease, and realised that these samples had come from children who had been admitted to hospital with a more persistent form of the infection, and several appeared to relapse with the same syndrome. When we investigated the antimicrobial susceptibility profile of the isolated *Shigella*, we observed that the bacteria were highly resistant to fluoroquinolones – the antimicrobials that are used routinely to treat this infection in Vietnam (and indeed globally). We then conducted more clinical and laboratory investigations and found more cases in Vietnam and further afield. Through genome sequencing and a group of international collaborators, we could accurately piece together the emergence of this novel

Eight to ten tons of bamboo rats are sold in the Mekong delta in Vietnam on a daily basis. Mr Liem displays his catch. Nguyen Thanh Liem

Bloody hell – a pig slaughter house in Ho Chi Minh City in Vietnam. Fact & fiction films

strain into Vietnam, other parts of Asia, Europe and Australia.

These finding were largely serendipitous, but if you are not looking then you cannot find. Unfortunately, this approach is not a long-term strategy for monitoring and preventing the emergence of such pathogens. Sadly, the infrastructure improvements and long-term health studies that are needed to achieve a more sustainable model in lower income countries are an expensive undertaking, but without them healthcare improvements and changes to infectious disease policy will be difficult to achieve.

A good example of where long-term healthcare data collection is making a difference to our understanding of disease emergence is in a project I am currently involved in with our sister unit, the Oxford University Clinical Research Unit in Nepal. Our host hospital (Patan Hospital in Lalitpur) in Kathmandu has made meticulous records of every organism they have isolated from the bloodstream of patients over 25 years. These data, collected systemically using the same methods, are revealing some very interesting patterns. They describe in exquisite detail how drug resistance has arisen in community-acquired Gram-negative pathogens over the past 10 years, which have become the dominant infections in this location. Without having some form of well-described longitudinal data we are only ever looking at time-stamped snapshots and are left largely second-guessing what the most important emergent pathogens are, and how we treat and control them.

All the examples of emerging infections (and the two locations) presented here are different. There is no 'one-size-fits-all' approach for best studying how pathogens emerge and how we can prevent them. We are trying to identify common traits for their emergence, but we are still some way from understanding the entire complexity of a single disease, let alone a group of them. However, while there are gaps in our understanding of how diseases emerge, we have some models in how we can stop them. To date, only two infectious diseases have been eradicated – smallpox in humans, and rinderpest in animals – and both were eradicated through the use of extensive vaccination campaigns. However, we are lagging behind in the development of new vaccines for emerging diseases, and there are numerous challenges to overcome in terms of vaccine design, testing, licensing and implementation. If a researcher were to find a potential vaccine target, it could take over 10 years to produce something useful. What we need to do better is develop a pipeline that allows us to identify specific aetiological agents and quickly turn them into vaccines. Imagine if there was a human *Brucella* vaccine – given that we know where the outbreak is in Vietnam, we could quickly vaccinate the at-risk population relatively quickly and curtail the ongoing outbreak.

Vietnam has changed beyond recognition since my arrival in 2007. Huge economic investment and political stability has had positive effects on healthcare in the country, and across the region. However, many challenges remain; a growing population, increasing demands for animal protein and the looming cloud of antimicrobial resistance in everyday pathogens suggest that Southeast Asia will continue to be a key region in driving global health security.

Acknowledgements

Stephen Baker is a Sir Henry Dale Fellow, jointly funded by the Wellcome Trust and the Royal Society (100087/Z/12/Z). Pictures were provided through a Wellcome Trust public engagement in science grant named 'Health in the Backyard' to Mary Chambers at Oxford University Clinical Research Unit in Vietnam.

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Annual Conference 2017 #Microbio17

Monday 3 April – Thursday 6 April 2017
EICC, Edinburgh, UK

Annual Conference 2017 is fast approaching, and this year promises to be a memorable event. Not only are we located in a fantastic building in the awe-inspiring location of Edinburgh, but we also have the largest programme we've ever had, with 29 scientific sessions covering the full spectrum of microbiology and over 200 invited speakers from around the world. You can register up to a week before the Conference with the following included in your registration fee.

Admission to all scientific sessions

There are four days of conference and 29 scientific sessions to choose from across the week, and you will have a range of opportunities to engage in and be inspired by the quality of research on offer. Our scientific community have done us proud once again by identifying the best of the best and the key trends in 2017. Plus, unlike some other conferences, you are not required to book onto specific sessions, meaning you can move around the event during breaks to really personalise your conference experience.

Admission to lunchtime events

There will be plenty of time during lunch breaks to enjoy the networking and food, as well as some additional talks and 'flash poster' presentations. So grab your lunch and head on over to the Live at Lunch sessions, or come and support those who are presenting a flash poster on our exhibition stand.

I. Atherton

Full access to the trade exhibition

You will have access to over 20 exhibitors who can provide you with information on the latest technologies, ideas on developing your career, and places to undertake new opportunities. Many of our stands also offer goodies, and once again you can take part in our Passport to Prizes to win an array of gifts donated by our exhibitors.

Full access to scientific poster sessions

Posters are a large part of our Annual Conference, and following our 2016 evaluation, we have strived this year to improve the experience for those presenting. During our Conference, posters will be on display around the exhibition hall and can be seen during all breaks and lunchtimes. Each evening and during Thursday's lunch hour, presenting authors will be on standby to talk to you about their work. We will no longer have parallel events taking place at the same time as the poster sessions, and all posters will be automatically entered into our four prize categories. The first set will be awarded by the Editors of our journals, the second chosen by members of the Early Career Microbiologists' Forum, while our Principal Investigators will select the third. The fourth 'People's Choice' award will be decided upon by delegates at the event using a voting slip. In addition, we will also be showcasing posters during the lunch break at our stand with flash presentations. Selected presenters will be given a slot for three slides and one quick-fire question. It will be an opportunity to tell you why you should


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Keep up-to-date with events, follow the Society on Twitter: **@MicrobioSoc**

go and view their work, and will be a fun and entertaining element to the posters this year! Catch them during lunch on Monday, Tuesday and Wednesday.

Hot buffet lunch plus tea and coffee breaks every day

Each day you will be provided with an inclusive lunch offering, and tea and coffee breaks at the beginning of the day, and during the mid-morning and afternoon breaks. Following feedback from our 2016 event, we have been working even harder with the venue to ensure your catering needs are met, especially around dietary requirements. There will be a hot food choice for everyone during lunch, and we'll ensure that drinking water is always available. Additionally, this year we will also provide some welcome refreshments to help you with those early starts throughout the conference week. As always, our events provide a fantastic platform to network, which is why we strive to provide you with the best catering possible onsite where your peers and colleagues await to connect with you!

Two free drinks vouchers during the poster viewing sessions on Monday, Tuesday and Wednesday evening

During the poster presentations at the Annual Conference, each delegate will be provided with two drinks vouchers to be used during the evening receptions. A variety of drinks are provided, including non-alcoholic drinks.

A delegate bag and conference material

Each delegate will be provided with a Microbiology Society bag on arrival, which will contain a conference guide to help you navigate your way around our event, as well as a pen, a lanyard and your free drinks vouchers.

Professional Development events – Enhancing your career at the Annual Conference

This year, the Society will be bringing back professional development sessions to the Annual Conference. Delegates will be able to attend sessions on Monday and Tuesday, with this year's topics on careers and scientific publishing. Look on our website for more information.


I. Atherton


I. Atherton

Pre-Conference networking

Sunday 2 April

18:00–21:00

Tickets: £20.00

On the Sunday ahead of our Annual Conference, we will be hosting a session to give early career researchers the chance to meet other delegates and to hone their networking skills.

Participants will get to take part in activities designed to help them meet as many people as possible, and also have the opportunity to practice networking with senior members of the Microbiology Society. This event is a perfect opportunity for delegates to gather an audience for their presentation later in the week, and meet future collaborators.

Tickets can be purchased for £20 and include a packed schedule of activities, dinner and drinks. Delegates can book via the online conference registration system on the Society website: **www.microbiologysociety.org/annualconference**.

Scientific publishing: writing and reviewing manuscripts

Tuesday 4 April
10:00–17:00

Effective communication of research is instrumental to the successful career of a scientist, and peer review is essential for the process of scientific publishing. These sessions will therefore give delegates a firm understanding of how to write a great manuscript, and also how to review fairly and accurately, directly from Editors of the Society's *Journal of Medical Microbiology*.

'How to write a manuscript' is a session aimed at PhD students, postdoctoral fellows and early career scientists who wish to understand what makes for an attractive manuscript. This will help those seeking to improve their skills in preparing a manuscript for a peer-reviewed journal.

'How to review a manuscript' is a session aimed at postdoctoral fellows and early career scientists who are looking to improve their skills in reviewing manuscripts for scientific journals. Many reviewers do not receive formal instruction or training. This workshop will guide attendees in the steps of constructively reviewing a manuscript.

To reserve a place on one of these free workshops, please choose the option while registering for the Annual Conference. Early booking is advised as places are strictly limited and offered on a first-come, first-served basis. Contact **profdev@microbiologysociety.org** for further details.

Maria Fernandes
Professional Development Manager

Dianndra Roberts
Editorial Development Coordinator

CuzediuWIAATjs

Post-PhD: finding a career that suits you

Monday 3 April
11:00–17:00

In an increasingly competitive job market (within and outside of academia), it is vital that PhD students and early career researchers take a proactive approach to their careers so that they maximise their chances to achieve career success, whatever that might be. To help you plan your career, we're offering delegates the chance to explore the opportunities available. During the morning session, academic careers specialist Sarah Blackford* will be taking participants through her PhD Career Choice Indicator, which she developed to show users how to identify initial career options by looking at their skills and passions and linking them to careers of interest. The aim of the session is to raise awareness and encourage a more strategic attitude towards career planning, and, as Sarah recommends, attendees will also be able to share their career ideas with peers and get a broader view of their career opportunities. To give participants an idea of the careers out there, the afternoon session will involve several case studies of scientists who have gone on to diverse careers after their PhDs, and the day will conclude with a peer-reviewed CV workshop.

Sarah Blackford's careers website (aimed at bioscientists working or studying in higher education) can be found at **www.biosciencecareers.org.*


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Keep up-to-date with events, follow the Society on Twitter: **@MicrobioSoc**

Prize Lecture winners

Our 2017 Prizes Lectures have been announced, and the winners will each present a Prize Lecture at the Annual Conference. Take a note of who is talking and when to avoid missing out. All Prize Lectures will take place in the Pentland Lecture Theatre, EICC, Edinburgh.

2017 Prize Medal

Professor Michael Rossman

Purdue University, Indiana, USA

Tuesday 4 April – 09:00

2017 Fleming Prize

Professor Stephen Baker

Oxford University Clinical Research Unit (OUCRU) in Ho Chi Minh City, Vietnam

Tuesday 4 April – 17:40

2017 Marjory Stephenson Prize

Professor Steve Busby FRS

University of Birmingham, UK

Wednesday 5 April – 09:00

2017 Colworth Prize

Professor Martin Ryan

University of St Andrews, UK

Wednesday 5 April – 17:40

Debate – 'Microbiome Research – opportunity or over-hype'

Monday 3 April – 17:40

On Monday afternoon, we will be hosting a lively debate on the recent microbiome research with a panel of experts who will discuss and debate if the research is an opportunity or if the microbiome is an over-hyped topic. The debate will be broad in scope, including the topics covered in the Microbiome Policy Project on health, agriculture and food, environment and sustainability. You can contribute to this discussion by submitting your questions via our Twitter feed or during the debate itself.

Social Programme Events

If you haven't already, don't forget to secure your place at our social programme events. There is limited space and tickets are selling fast.

Quiz Night
Venue: Ghillie Dhu

Tickets £25.00

Monday 3 April – 20:30

Join us on Monday night at the **Ghillie Dhu** for our Annual Conference quiz night, where we will put your trivia, celebrity, sporting and microbiological knowledge to the test! If you're up for the challenge, you can secure your ticket online when registering for the Conference. The evening also includes a two-course meal and a welcome drink, plus prizes for the winning team and losing team! Teams can be set up on the night or arranged in advance, with up to eight people per team so everyone can get involved. Tickets are limited. Cash bar onsite.

Traditional Ceilidh
Venue: The Hub

Tickets £50.00

Wednesday 5 April – 20:00

Join us on Wednesday evening at **The Hub** for dinner and a dance to celebrate the last night at the Annual Conference. Tickets can be purchased online when registering for the Conference, and prices include a glass of sparkling wine on arrival, a five-option buffet and half a bottle of wine per person. All of this will be followed by a highly recommended, four-piece ceilidh band called *Reel Time*, who will get you onto the dance floor to learn some traditional but simple ceilidh dancing! Tickets are limited. Cash bar onsite.

Focused Meetings 2017

Keep up-to-date with events, follow the Society on Twitter: **@MicrobioSoc**

This year we have some fantastic meetings taking place, organised by our members, that focus on specific subjects in microbiology. Further information about the deadlines for grants, abstract dates and how to register can be found online at www.microbiologysociety.org/events.

Dr_Microbe/ iStock/Thinkstock

#AgriFoodSec17

Microbial Resources for Agricultural and Food Security

21–23 June 2017 – Belfast, UK

http://microb.io/agrifoodsec17

#AMROneHealth17

Antimicrobial Resistance and One Health

29–30 August 2017 – Co. Kildare, Ireland

http://microb.io/AMROneHealth17

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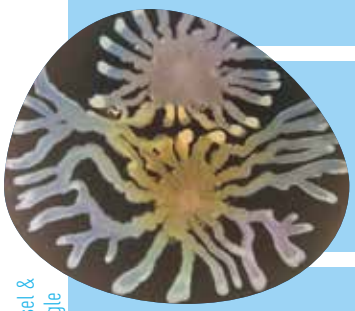


Edgar Lissel & Steve Diggle

#Pseudomonas17

16th International Conference on *Pseudomonas*

5–9 September 2017 – Liverpool, UK

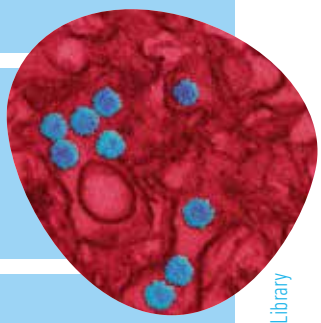
http://microb.io/pseudomonas17

#IMAV17

International Meeting on Arboviruses and their Vectors (IMAV)

7–8 September 2017 – Glasgow, UK

http://microb.io/IMAV2017



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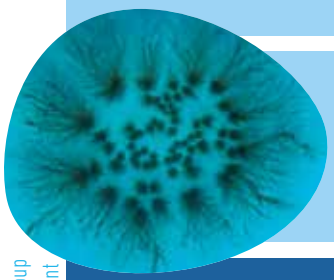

Kent Fungal Group University of Kent

#BYGVOY17

British Yeast Group (BYG) – The Versatility of Yeasts

11–13 September 2017 – Kent, UK

http://microb.io/BYGVOY17

Get involved

The above meetings were all submitted through the Microbiology Society's proposals scheme, which welcomes new ideas and topics every year for events that will bring together the microbiological community. To put forward ideas for meetings in 2018, please complete the Focused Meeting proposal form (**www.microbiologysociety.org/proposals**) by **15 June 2017** and submit it to **conferences@microbiologysociety.org**.

33RD INTERNATIONAL SPECIALISED SYMPOSIUM ON YEASTS

Exploring and Engineering Yeasts for Industrial Application

26–29 JUNE 2017
UNIVERSITY COLLEGE CORK, IRELAND

Topics will include:

- Exploration of yeast biodiversity for industrially relevant traits
- Hybrid genomes of industrial yeasts: analysis and engineering
- Analysing and engineering regulatory networks in yeast
- Evolutionary approaches for yeast strain improvement
- Metabolomics and proteomics of industrial yeasts
- Engineering novel-to-yeast product pathways
- New tools for yeast genome engineering
- New synthetic pathways in yeast

Abstract submission and registration is now open

Confirmed Speakers:

Pascale Daran-Lapujade
(Delft University of Technology, Netherlands)
Hisashi Hoshida
(Yamaguchi University, Japan)
Diego Libkind
(National University of Comahue, Argentina)
Ed Louis
(University of Leicester, UK)
Steve Oliver
(University of Cambridge, UK)
Merja Penttilä
(VTT Technical Research Centre of Finland, Finland)
Amparo Querol
(Institute of Agrochemical and Food Technology, Spain)
Christina Smolke
(Stanford University, USA)
Jack Pronk
(Delft University of Technology, Netherlands)
Dina Petranovic
(Chalmers University of Technology, Sweden)
Karin Voordeckers
(University of Leuven, Belgium)
Simon Hubbard
(University of Manchester, UK)

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Microbiology Society members receive a discount for our meetings and are eligible for our grants.
Other bursaries are available - see website for details: www.microbiologysociety.org (terms and conditions apply)

MICROBIOLOGY SOCIETY

ISSY33 Cork, Ireland 2017

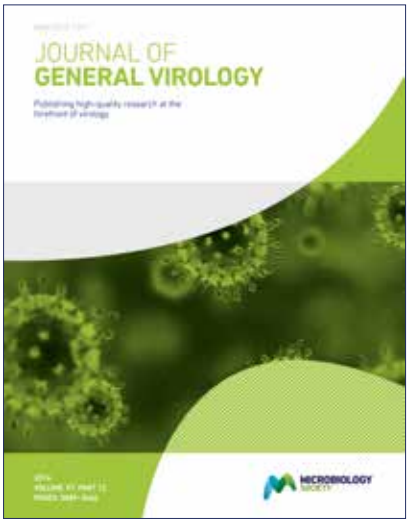
@MicrobioSoc
#ISSY33
http://microb.io/ISSY33

Publishing

Journal of General Virology turns '50'

This year marks the 50th birthday for one of the Society's stable of peer-reviewed journals, *Journal of General Virology*. The first issue of *Journal of General Virology* was published in January 1967, in response to the growing number of submissions in virology to *Journal of General Microbiology* (now *Microbiology*).

Journal of General Virology was founded by distinguished virologists Colin Kaplan and Peter Wildy, who became the first Co-Editors-in-Chief. Colin Kaplan served as Editor-in-Chief for five years; Peter Wildy took on the role of President of the Society for General Microbiology (now Microbiology Society). The journal has published several significant discoveries over the years, and many talented Editors have worked on its Editorial Board.



The discipline of virology has changed over the past 50 years. However, the journal has maintained an international leading reputation in the field, illustrated by its rise in Impact Factor. Today, the journal continues to publish high-quality research articles, reviews and short insight reviews, covering the full range of viruses from animal and plant to bacteriophages. The diverse scope includes molecular biology, immunology, virus–host interactions and antivirals/vaccines. The journal also offers authors a gold open access option, known as OpenMicrobiology.

To mark the half-century, the journal will be running various promotions throughout the year, including an article collection of the past 50 years, insights into the journal from our Editors and poster prizes.

Journal of General Virology would like to announce that Paul Duprex has taken the position of Deputy Editor-in-Chief. Paul is currently at the School of Medicine, Boston University, in the Division of Graduate Medical Sciences. His research programme focuses on areas such as understanding the molecular basis of paramyxovirus pathogenesis. Paul is Director of Cell & Tissue Imaging at Boston University's National Emerging Infectious Diseases Laboratory (NEIDL).

If you would like to know more about *Journal of General Virology*, please visit the journal's homepage (**jgv.microbiologyresearch.org**). If you would like to submit a paper to the journal, please do so using our online submission system (**www.editorialmanager.com/jgv**).

Shalene Singh-Shepherd
Editorial Office Coordinator

Mark Harris
Editor-in-Chief

Welcome to our new *Journal of Medical Microbiology* Editors-in-Chief!

Journal of Medical Microbiology is welcoming **Norman Fry** and **Kalai Mathee** as new Co-Editors-in-Chief.

Norman is currently a Clinical Scientist at Public Health England's National Infection Service in London, holding the following roles:

- Deputy Head of the Respiratory and Vaccine Preventable Bacteria Reference Unit
- Head of the Vaccine Preventable Bacteria Section
- Head of the World Health Organization Collaborating Centre for *Haemophilus influenzae* and *Streptococcus pneumoniae*

Kalai is currently at the Hebert Wertheim College of Medicine, Florida International University, with her research programme focusing on areas such as the molecular pathogenesis of *Pseudomonas aeruginosa* and antimicrobial resistance. Kalai is in the following roles:

- Professor of Molecular Microbiology & Infectious Diseases
- Associate and Founding Director of Global Health Consortium

Dianndra Roberts
Editorial Development Coordinator

Microbial Genomics partners with an epidemic tracking platform

Microbial Genomics has partnered with Microreact (**microreact.org**), a free data visualisation and sharing platform that allows scientists and health professionals worldwide to better collaborate to understand disease outbreaks.

This partnership will allow *Microbial Genomics* authors to provide extra context to their articles, promoting open availability and access while building a unique resource for global health professionals and scientists.

Microreact allows full data and metadata sets to be uploaded via a web browser, which can be shared through a permanent web link. This was developed in the David Aanensen Research Group, Imperial College London and The Centre for Genomic Pathogen Surveillance. More information on Microreact can be found at 10.1099/mgen.0.000093.

Nicola Wise
Publisher

Journal of Medical Microbiology and *Microbiology* introduce Short Communications and Letters to Editor

Article types are changing for *Journal of Medical Microbiology* and *Microbiology*. *Journal of Medical Microbiology* has separated the Correspondence article type into two sections – Short Communications and Letters to the Editor; *Microbiology* has introduced Short Communications to its current article types.

Short Communications are an alternative format for describing smaller novel pieces of completed work. The concise nature of these article types will allow for rapid peer review and can aid in the outreach of present topics to a wider audience.

Letters will allow authors to address personal observations and opinions, or alternative interpretations of others' work. Letters can be utilised as a response to recently published work and can bring a different viewpoint of the subject matter. Discussions amongst the community will emanate from this article type and will allow for a greater understanding of research.

If you would like to submit via our online submission system please see **www.editorialmanager.com/jmm** and **www.editorialmanager.com/mic**. Further information on the journals can be found at **jmm.microbiologyresearch.org** and **mic.microbiologyresearch.org**.

Sid Islam
Editorial Office Coordinator

I. Atherton

Early Career Microbiologists' Forum Update:

new Undergraduate Representative and preparing for Edinburgh

The first ECM Executive Committee took office last month and your representatives have already been hard at work! We are excited to welcome Amiee Allen from the University of Kent to the Committee as our first Undergraduate Representative. Amiee will be key in reaching a wider audience of potential ECM Forum members, and plans to liaise with different universities in order to communicate any upcoming Microbiology Society opportunities. This way, we hope to provide undergraduates with the skills and encouragement needed to pursue microbiology-based careers.

We are also gearing up for our first Annual Conference as the Forum's Executive Committee and have been implementing ideas on how to ensure that ECM Forum members can get the most out of their time in Edinburgh. Your Conferences Representative, Amy Richards, has been involved in refreshing the poster sessions at the Annual Conference. These initiatives include flash posters and a range of prizes that will improve the experience for both audience and presenter. There will also be the opportunity to help out with various tasks at the event so please do get involved when the time comes. The networking event on the Sunday is also a fantastic opportunity to mingle with new people in a semi-structured way; speaking as an unsociable introvert I can attest to how beneficial this session can be!

As a final note, we are here to represent your views and opinions so please do get in touch with us if you have any suggestions or ideas. We are keen to publicise the work of Forum members on Twitter, so whether that is a new paper, an outreach activity or something similar, tag **@RebeccaJHall13** and **@MicrobioSoc** in your tweets and we will try to get them promoted.

We hope to see you all in April!

Rebecca Hall
Communications Representative,
ECM Forum Executive Committee

I. Atherton

Outreach

Big Biology Day

The Microbiology Society attended Big Biology Day Cambridge, an annual event that attracted over 2,000 families, hosting a lunchtime panel discussion on the human microbiome and exhibiting its Antibiotics Unearthed project.

Human microbiome panel discussion

The Society ran a panel discussion attended by over 40 members of the public about the microbes that live in and on you, known as the human microbiome. The panel included Dr Marc-Emmanuel Dumas from Imperial College London, Dr Hilary Browne from the Sanger Institute, Cambridge, and Dr Michelle Beaumount from King's College London.

After short presentations from the speakers, the audience asked their questions. Areas of intrigue included whether the microbiome changes as we age, whether any probiotic drinks are in clinical trials, and who first decided to try faecal transplants.

The Microbiology Society has identified the microbiome as a growing area in the public consciousness, and this event is part of our efforts to engage people about the potential benefits of this area of research and the challenges it may need to overcome.

Visit our blog, Microbe Post, for more information about the microbiome event (**http://microb.io/2eXbK3b**).

Antibiotics Unearthed

The Antibiotics Unearthed Team attended Big Biology Day Cambridge, as part of the Biology Big Top, to engage with the public about antimicrobial resistance (AMR). The Biology Big Top is a joint touring stand with other biological learned societies and in Cambridge we presented alongside the Biochemical Society, Royal Society of Biology and NESTA. The Team encouraged participants to use microscopes to examine plates containing the soil-dwelling microbes, *Streptomyces* (kindly provided by Dr Paul Hoskisson, University of Strathclyde), to see if they could spot any antibiotic-producing bacteria. Find out more about Antibiotics Unearthed here: **www.microbiologysociety.org/antibioticsunearthed**.

Many people who visited the stand were aware of antibiotic resistance but did not know that a large number of current antibiotics are derived from soil-dwelling bacteria. Visitors had lots of questions about why AMR is becoming a problem and ideas about alternative solutions, such as reducing environmental usage of antibiotics. Several attendees are taking part in the citizen science part of the project and have sent in soil samples to be tested by Ethan Drury, our PhD student at University of East Anglia, for antibiotic activity.

The Antibiotics Unearthed Team and the Biology Big Top will be visiting events throughout 2017 so keep a look-out for one near you.

Andrew Day
Public Affairs Intern

Hannah Forrest
Public Engagement Officer
h.forrest@microbiologysociety.org

New Scientist Live

In September, the ExCeL arena in London hosted New Scientist Live, a huge festival of science and technology. During the event, the Microbiology Society collaborated with the Biochemical Society to organise a panel discussion about the problem of antimicrobial resistance entitled 'When A Scratch Can Kill'.

The panel was made up of: Anthony McDonnell from the Review on Antimicrobial Resistance; Tamar Ghosh from the Longitude Prize; Dr Caroline Barker, a consultant microbiologist; and Professor Laura Bowater from Norwich Medical School. Anthony reinforced public health messages discouraging unnecessary use of antibiotics, as this is an important driver of resistance. In a recent survey, over a third of young people didn't know that antibiotics are only effective against bacteria. Tamar highlighted the Superbugs game, a mobile app developed by the Longitude Prize to combat this problem by engaging young people and educating them about AMR.

Despite the warnings given by all the speakers, Dr Barker remained hopeful, referencing the many public health measures, such as sanitation and immunisation, that have reduced the burden of killer diseases like diphtheria and whooping cough in the past. The message from the panel was that AMR is a global problem and we are part of the solution. Professor Bowater concluded the discussion by telling the audience that the solution to AMR was "in your hands".

Listen to our podcast from the event (**http://microb.io/2cGh6lD**) and view our videos on the Society YouTube channel.

Membership Q&A

This is a regular column to introduce our members. In this issue, we're pleased to introduce Marilia Costa.

M. Costa

Where are you currently based?

University of Dundee in Scotland.

What is your area of specialism?

Molecular microbiology with an emphasis on gene regulation and protein secretion.

And more specifically?

Understanding the role of a post-transcriptional regulator, and an RNA-binding protein in the synthesis and secretion of chitinases by a Gram-negative bacterium.

Tell us about your education to date.

I obtained my BSc in Pharmacy from the Paraiba State University (2011) in Brazil. After that I did six months at the Intensive English as a Second Language course at the University of Texas at El Paso (UTEP), USA, and a semester at the New Mexico State University (NMSU) to improve my English language skills (2012) to prepare for my postgraduate studies. I then took up a PhD scholarship at the University of Dundee to study Molecular Microbiology.

Where did your interest in microbiology come from?

During my undergraduate studies I learned about clinical microbiology and its use in quality control. Using this information I developed a pilot project to microbiologically test the water used to wash vegetables in a flea market in Brazil and won a prize for the project. I also worked as a pharmacy assistant for a university hospital to learn more about antibiotic therapy and antimicrobial resistance.

What are the professional challenges that present themselves, and how do you try to overcome them?

At a scientific level: I would say the use of new technologies and establishing collaborations. It is crucial to stay up-to-date and apply new methods. A more collaborative environment among scientists is also needed to facilitate implementation and speed up discoveries. The delay in publishing research also slows down progress and its application in society.

At an educational level: the lack of scientists involved in science communication. It is extremely important to engage the public, not only to inspire the new generation but for people to understand the work scientists carry out with public funding.

What is the best part about 'doing science'?

I have no doubt that, for me, the best part of doing science is talking about it! I truly enjoy presenting my work. I am so excited about science and like to discuss and consider questions with my peers, and engage with the public at events.

Who is your role model?

I have met so many amazing scientists along the way. I am inspired by clever and humble scientists that truly love science and are willing to help, discuss, and share their knowledge in an altruistic way.

What do you do to relax?

I love doing yoga, playing indoor football, cycling and listening to music. Yoga is the best way to relax.

What one record and luxury item would you take to a desert island?

It is not easy to choose a single record but I would choose *Day & Age* from The Killers. In regard to the luxury item, I would say a very comfortable pillow.

Tell us one thing that your work colleagues won't know about you.

I think my work colleges assume I am very expressive as I am from Brazil, but the truth is that it is mostly due to my drama classes. I have performed at local theatres and know circus tricks.

If you weren't a scientist, what would you be?

It would be a communications role, such as a journalist. However, I am very glad that I can combine this passion with my actual career and work in positions that require both skills, as part of science communication.

If you would like to be featured in this section or know someone who may, contact Paul Easton, Head of Membership Services, at **p.easton@microbiologysociety.org**

Improving the development and deployment of rapid diagnostic tests in low- and middle-income countries

Marilia Costa is a Society Champion and final-year PhD student based at the University of Dundee. She recently attended a one-day workshop on 'Improving the development and deployment of rapid diagnostic tests in low- and middle-income countries'. The workshop was hosted and run by the Academy of Medical Science in London.

Rapid diagnostic tests (RDTs) are revolutionising how disease is diagnosed and treated, and are helping to deliver higher standards of healthcare and greater efficiency across public and private healthcare sectors, as well as at the community level. This is what Marilia took from the workshop.

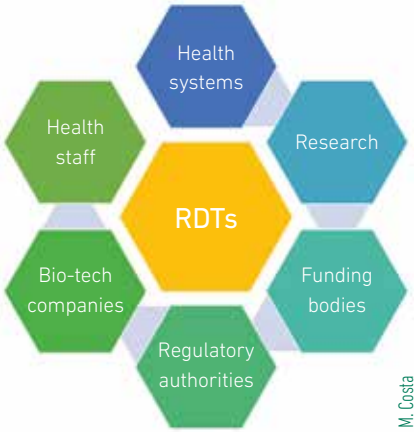
What is the actual context of RDTs?

Although the increase in human mobility supports the economy and development of countries, from the view of public health, such globalisation is a perfect formula for the fast transmission of diseases. The lessons learned from previous outbreaks are clear: we need to be prepared, and the development of rapid diagnostic tests is essential in making progress by avoiding misdiagnosis and unpredictable transmissions.

The need for reliable, accurate and sensitive tests for rapid diagnostics increases during outbreaks, such as during the emergence of Ebola and Zika in recent years. These tests also need to be at low cost, be easy to use (limited training required) and be able to deliver a fast result, in order to be used in rural and remote areas. The challenge lies in combining all these characteristics in an RDT.

Professor Rosanna Peeling opened the workshop by setting the scene about RDTs and highlighting several important factors, such as the lack of investment, regulatory oversight and international standards necessary for more advances in the field of diagnostic tests.

Examples of successful RDTs were mentioned, such as the HIV and syphilis rapid tests. However, an important fact is that even when a test presents 99% accuracy, it means that over a million of patients worldwide will be misdiagnosed as part of the 1% inaccuracy window. In addition, Professor Lisa Hall mentioned an example – rapid glucose tests are very successful in sales (top 50) although they are not cheap. She also discussed RDT as an add-on to mobile phones.



M. Costa

What are the major challenges in developing RDTs?

In fact, RDT development has to face several barriers involving much more than the science and technology behind them. The lack of funding and clear regulatory policies, and the challenge in lowering product cost and in implementing them in healthcare systems, are just a few to be considered. RDTs were pointed to be less regulated than medicines, which led to some non-reliable tests being placed on the market. Since countries have different policies, professionals from various sectors would like clear international standards regarding RDTs.

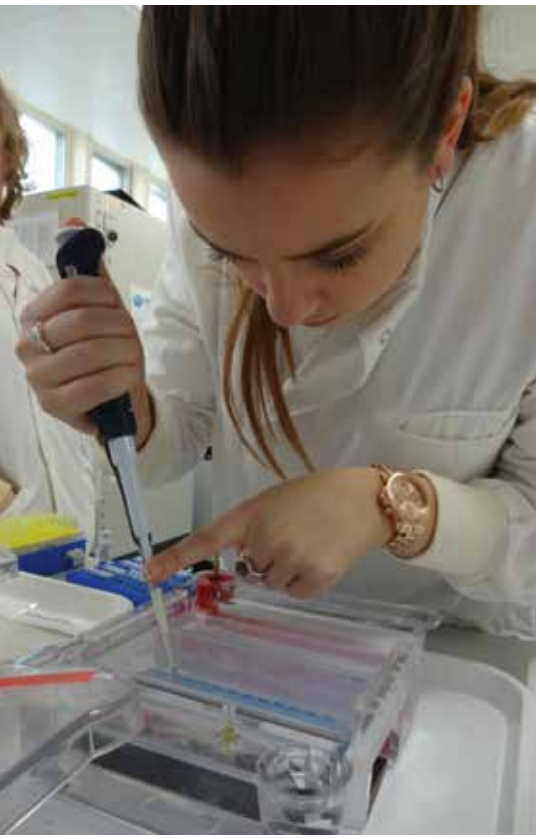
How researchers can contribute to advances in RDTs?

As a group of researchers, we discussed this matter and found out that scientists are isolated from the business of RDTs. We proposed a more collaborative environment as researchers might hold important discoveries that support the development of new technologies. Improving connections between researchers/academics, health staff, health systems, the NHS and biotech companies is essential for advances. Agreements among collaborators could solve the barrier involving intellectual property and patents. Moreover, a world bank of serum and cells, composed of several positive and negative samples, could be used as a starting point for testing any new RDT. Thus, it could diminish discrepancies in some RDTs after being used on specific populations.

An example of the difficulties in establishing collaboration is the fact that technologies could be combined for a multiple diagnosis in a single RDT. However, there is little interest from a business perspective, as it involves collaboration between companies.

Marilia Costa
University of Dundee

Schoolzone



Newton Abbot College students working with University of Exeter researchers. A. Wideman

Teaching antimicrobial resistance in schools

Antimicrobial resistance (AMR) is one of the biggest global health concerns and is an important issue facing everyone today. AMR has received considerable media coverage and world leaders are acknowledging the importance of this threat, but the message still needs to get across. There are many ways to educate and inform people about AMR.

One of the ways the Society is doing this is through the Antibiotics Unearthed School Partnership programme (**www.microbiologysociety.org/AUpartnership**). Our participating schools are passionate about practical microbiology and are partnered with a university, research institute, hospital laboratory or similar. Groups of students do real research, hoping to find the next new antibiotic from soil. The aim is to inspire young people, through experiencing real research, to have a career in science. Here, one of our participating teachers, Alicia Wideman from Newton Abbot College, describes her experience with the project.

Antibiotic resistance education in secondary education

As a result of my past academic endeavours in the fields of both cell biology research and science education, I am always looking for opportunities to engage my students in authentic inquiry-based scientific research opportunities. The Microbiology Society's Antibiotics Unearthed project has provided Newton Abbot College A-Level Biology students a unique and rare opportunity to do just that, alongside researchers at the University of Exeter.

This project enables students to engage in inquiry-based learning using state-of-the-art molecular biology research techniques in an attempt to

Newton Abbot College students at University of Exeter. A. Wideman

Newton Abbot College students presenting their poster at the Society's Annual Conference. A. Wideman

discover novel antibiotic-producing soil bacteria to combat the worldwide issue of antibiotic resistance. Integrating Antibiotics Unearthed (AU) within the context of an A-Level Biology class proved to be pedagogically beneficial on numerous levels as outlined below.

1. AU complements and challenges the student's understanding of their A-Level curriculum content as the project contextualises aspects of the course within a real world application (antibiotic mechanism of action, antibiotic resistance and evolution) while providing students the opportunity to conduct experiments that are theoretically included in the A-Level curriculum (PCR, gel electrophoresis, DNA sequencing). Year 13 student Rachel Spooner said that this project was "good for lab experience because you got to try loads of new techniques you have never done before. Particularly the ones that you learned about in class, but never had the chance to try them, so it backs up your knowledge."
2. This project strengthens scientific literacy skills as students are expected to write a research proposal outlining their rationale for the project and their site selection for collecting their soil samples using primary scientific literature and Microbiology Society-produced adapted literature. The students also prepared a research poster for the Microbiology Society's Annual Conference, where two students presented their findings to fellow students and the wider scientific community, thereby increasing their scientific communication skills.
3. Authentic inquiry-based science, such as AU, provides opportunities for students to engage with their learning on a deeper and more meaningful level as they take ownership of their research and their findings, as evidenced by student Steven East's comment: "We were able to capture a snapshot into the biological diversity of our home counties which was really quite awe-inspiring."
4. AU provides insight into, and experience with, authentic science – shedding light on both the true process and nature of science that is not easily communicable to students otherwise, as evidenced by the comments by Year 13 student Silas Fowler: "Going to Exeter University gave us all a real understanding of how real science works and how postgraduate research works," and Caitlin Stalker: "We learned collectively that patience is a virtue, because not all of our experiments worked the first time."

Ultimately, the project was a success in terms of pedagogical outcomes. The teacher in me was inspired by the educational value of the project and the impact it had on the students. However, the scientist in me was admittedly disappointed by our lack of novel results. This dichotomous conclusion is one that I think inevitably exists within a teacher that attempts authentic science in the classroom. Although the scientist in me desires to discover, this project has exemplified that, as is the case with authentic science, discovery is only a small part of the scientific process.

Alicia Wideman
Newton Abbot College, Devon

Applications for Antibiotics Unearthed are now open!

If you would like to participate in Antibiotics Unearthed as a School Partnership or in the Undergraduate Programme, applications are now open! All the information can be found here: **www.microbiologysociety.org/antibioticsunearthed** or by contacting **antibioticsunearthed@microbiologysociety.org**.

Global action on antimicrobial resistance

Antimicrobial resistance (AMR) is estimated to cause at least 700,000 deaths globally each year. The Review on Antimicrobial Resistance, which was commissioned by the former UK Prime Minister and published its final recommendations last year, projected that, without urgent action, AMR-related deaths could rise to 10 million each year and cumulatively cost the global economy up to $100 trillion by 2050. Strong messages from the Review and wider health and science communities contributed to increasing recognition from international policy-makers, throughout 2016, about the need to tackle the global threat AMR poses to health, economies and sustainable development.

In May 2016, the G7 built on previous AMR declarations by issuing a 'Vision for Global Health' that committed them to strengthening international co-operation, and promoting research and development spending to combat AMR. These commitments were echoed at the first G20 summit to address AMR, in China in September, which issued a statement calling for prudent use of antibiotics and a consideration for affordability and access. Importantly, the need for a One Health approach across human and animal health and agriculture and the environment has been recognised, including through supporting the work of the World Health Organization (WHO), Food and Agriculture Organization (FAO), and the World Organisation for Animal Health (OIE).

The United Nations (UN) General Assembly held a High-Level Meeting on AMR in New York in late September last year. This culminated in all 193 member countries making a landmark declaration to take international, co-ordinated action across health, agriculture and other sectors, to tackle the causes of AMR. Countries without national AMR action plans also reaffirmed commitments to develop these based on the WHO's Global Action Plan on AMR. This was only the fourth UN Declaration on a health issue, following those on HIV, non-communicable diseases and Ebola.

Delivering sustained international action and investments to deliver on these commitments and plans is now the key challenge. We have seen some further action from international partnerships. For example, the UK and China partnered on a joint AMR research, funding initiative and are contributing $50 million each to initiate a Global Antimicrobial resistance Research Innovation Fund. The evaluation of the European Commission's 2011 AMR Action Plan, to which the Microbiology Society contributed, also showed some initial achievements including: greater participation in European Antibiotics Awareness Day; AMR research and development funding programmes; and various activities to promote better usage of antimicrobials and surveillance. The Commission will be scaling up its efforts with a new action plan in 2017.

Over 2016, the Microbiology Society's Policy team were involved in several activities to raise awareness of AMR and the importance of microbiology. Dr Isabel Spence, Head of Public Affairs, participated in discussions at a Ministerial side event to the UN meeting in New York, which included ministers representing the UK, Australia, Argentina, Kenya, South Africa and Sweden. GlaxoSmithKline's Chairman of Vaccines announced an Industry Roadmap for Progress on Combating Antimicrobial Resistance. Created by 13 of the world's largest pharmaceutical companies, the roadmap includes commitments to improve access to antibiotics and reduce environmental impacts from their production.

Policy Officer Dr Paul Richards represented the Microbiology Society and the Learned Society Partnership on AMR (LeSPAR) at Science and Stormont 2016, which brought together the science community and members of the Northern Ireland Assembly to discuss AMR. Society Irish Division member, Dr Fiona Walsh, presented about AMR in the Environment. The Society, as a member of LeSPAR and the European Federation of Biotechnology (EFB), also supported a Biology Week 2016 public debate on the role of innovation and regulation in tackling AMR, chaired by EFB Vice-President and Society member Professor Jeff Cole.

Andrew Day
Public Affairs Intern

Paul Richards
Policy Officer
policy@microbiologysociety.org

Podcast – *Microbe Talk*

At the end of last year, we had the rare opportunity to visit the National Emerging Infectious Diseases Laboratories (NEIDL), part of Boston University, guided by Society member (and *Journal of General Virology* Editor) Professor Paul Duprex.

In another emerging disease podcast, we spoke with Professor Jonna Mazet at UC Davis about an ambitious programme to discover and catalogue viruses of pandemic potential.

Boston University Photography/Tim Llewellyn

YouTube channel

While in Boston, we interviewed delegates at the EIDA2Z meeting, including science writer David Quammen and Sir Roy Anderson from Imperial College London.

For Antibiotic Awareness Week, we produced another of our popular stop-frame animations, this time about how resistance develops. Dr Derek Gatherer from Lancaster University told us how Zika virus has circumnavigated the globe, and we learned about epidemics by playing the video game Plague Inc. with Dr Rosalind Eggo from the London School of Hygiene & Tropical Medicine.

The latest from the Microbiology Society

Find out what you may have missed from the Microbiology Society. This is a roundup on some of the latest from each of our channels, with details of where you can find them.

Blog – *Microbe Post*

Our *On the Horizon* series continues, with us learning about hantaviruses from the Animal & Plant Health Agency's Dr Lorraine McElhinney and about monkeypox from Anne Rimoin, Associate Professor at the UCLA Fielding School of Public Health.

Last autumn we began a new series that sees Harry Smith Vacation Studentship awardees give us an overview of their projects. Topics included an investigation into the microbiome of tardigrades, and the search for yeast prions.

Phineas Jones

Facebook

The Society has been experimenting with Facebook Live – the platform's new broadcast system.

At the end of last year, we visited Science Gallery London's 'Mouthy' event, interviewing researchers and artists about their work making bacteria-infused ceramic glazes and growing teeth from bacteria.

Look out for more of our live broadcasts at the Annual Conference and over the next few months.

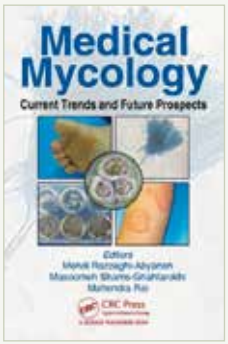
The Microbiology Society is producing more content than ever before – don't miss out!

Reviews

Medical Mycology: Current Trends and Future Prospects

Edited by M. Razzaghi-Abyaneh, M. Shams-Ghahfarokhi & M. Rai
CRC Press (2015)
£95 ISBN 978-1498714211

There is a fair amount of competition for this book, which aims to provide an overview of medical mycology with a special emphasis on fungal diagnostics. In reality it is rather an orthodox work that does less well in addressing 'future prospects' than on 'current trends'. For example, there is little or nothing on the impact that next-generation sequencing and other omics technologies are having in the field, and it instead focuses on established methodologies in cytology, immunoassays and PCR. There is, however, a useful chapter on mass spectrometery MALDI-TOF methods. The chapters have some unusual vignettes that reflect the specialist interests of the contributing authors. This means that coverage of the field is not comprehensive and is often patchy. Nevertheless, there are some interesting contributions that specialists would find valuable. There are some eccentric, very long tables listings, for example, extended inventories of isolates of specific fungi isolated in Iran and of case reports of *Curvularia* infections. An unfortunate aspect is that the book contains quite a lot of intrusive formatting and spelling errors – a feature of the times perhaps where the costs of copy-editing are increasingly cut back. In summary, the feel of the book is therefore more of a collection



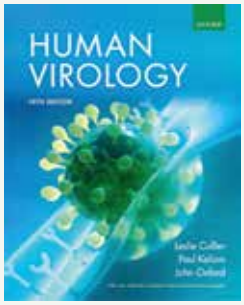
of vignettes or essays on topics in the field rather that a coherent treatise suitable for a general introductory text in medical mycology. There is a strong emphasis on fungal skin infections, and students of this area will find more of interest.

Neil Gow
University of Aberdeen

Human Virology (5th Edition)

Edited by J. Oxford, P. Kellam & L. Collier
Oxford University Press (2016)
£39.99 ISBN 978-0198714682

Human Virology, now in its 5th edition, builds on the success of the previous ones, with new features such as additional and updated figures, hot topic boxes outlining cutting edge research, and more detail on pathogenesis. It claims to be "The only introductory undergraduate text to focus on human virology", which may have been the case at the time of the book's release, but is not the case now. Furthermore, one cannot underestimate the understanding of virology that has been gained by studying viruses that infect prokaryotes and other eukaryotic species. In my opinion, the book goes way beyond the level of understanding required to meet the learning outcomes of most undergraduate microbiology-based modules but this will only serve to encourage more enthusiastic students to challenge themselves to further their understanding. The book is divided into three main sections covering the more general principles (structure, replication, pathogenesis, resistance to infection, epidemiology), the details of specific virus groups, and more practical aspects focusing on diagnosis, immunisation and antiviral therapy. Figures and tables



are very clear, and the entire book is extremely readable. Each chapter ends with reminders of the key points, examples of further reading and questions to help students to assess their understanding. In addition, an online resource centre contains MCQs, web links to animations and videos for students, and copies of the book's figures for instructors to use in their teaching. It is certainly up-to-date, being the only undergraduate student virology textbook I have seen to date that mentions Zika virus. It is extremely good value, and I would recommend it to any student of virology. It is clearly aimed at undergraduate level but there is material in the book that will be useful for postgrads and postdocs too.

Christopher Ring
Middlesex University

Comment

Why don't we do this more often?

Michael D. Baron

African buffalo. DAJ/Thinkstock

In the last 50 years, we have managed to eradicate one human disease and one affecting cattle. There are lessons to be learned from these successes, to be sure, but also important lessons to be learned from asking ourselves why we haven't done more.

Rinderpest, aka 'cattle plague', was with us for at least 2,000 years. Over the centuries, the rinderpest virus (a morbillivirus, closely related to the human pathogen measles virus) killed uncounted millions of cattle and buffalo in Asia and Europe. When it was introduced for the first time into Africa in the late 19th century, it killed ~90% of the cattle and buffalo on the continent in the ensuing 20 years.

Now, after many decades of hard work across Africa, the Middle East and Asia, rinderpest has been declared eradicated (in 2011); there has not been a case of the disease, anywhere, for more than 15 years. There is no doubt that this was a great achievement. It is only the second viral disease ever eradicated, following on from the elimination of smallpox from humans in the 1960s and 70s. There was much celebration and mutual back-slapping, within both the small (but select!) band of livestock virologists and the global veterinary community in general.

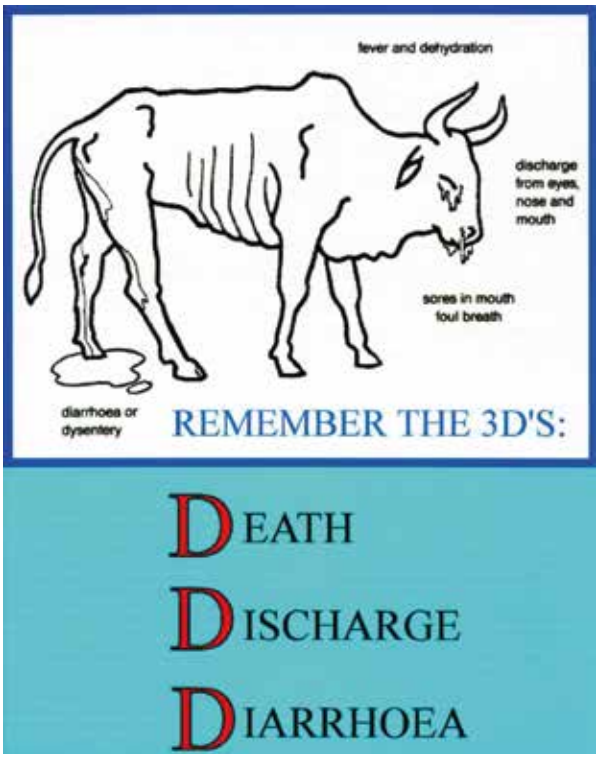
Much has been written since as to how rinderpest virus was eradicated: the various contributions of vaccines; diagnostics; the building up and co-ordination of national veterinary services; community education; surveillance; epidemiology; and so on. It is fairly easy to show that rinderpest fits the main criteria for an eradicable disease, with interruptible transmission (either by slaughter or vaccination) and ready diagnosis ("The three Ds: discharge, diarrhoea and death"). Although there was concern as to whether wildlife formed a reservoir of infection (as is the case with foot-and-mouth disease virus, for example), this turned out not to be the case, and stopping rinderpest in livestock also stopped it in susceptible wildlife species (giraffe, wild buffalo, various antelopes). It was also easy to calculate that it would be economically worthwhile to eradicate the disease, since the cost of eradication (spread over 20 years or so) was always going to be less than the savings that accrue when the disease is gone, vaccination and surveillance don't have to be done any more, and the downstream benefits of improved cattle productivity and trade kick in. With those factors in place, it became a matter of the political will to fund the work, and the effort of organising many people in many countries to carry through the programme, efforts that largely fell to the World Organisation for Animal Health (OIE) and the United Nations' Food and Agriculture Organization (FAO).

The effort was clearly worthwhile, and the OIE and FAO liked the feeling so much that they have decided to do it again, with another morbillivirus, peste-des-petits-ruminants virus (PPRV), which causes severe disease in sheep and goats, and is set for eradication by 2030 if the funding can be found.

An interesting question is why, given that rinderpest and measles viruses are each other's closest relatives, and that the current vaccines for both appeared at about the same time (the early 1960s), measles hasn't gone the same way? Measles caused >134,000 deaths in 2015, and that is after vaccination has reduced global mortality by 90%, yet there has been a reluctance to set global eradication of measles as a target, and it only explicitly entered the strategic plan of the World Health Organization (WHO) in the last five years; prior to that the aim was 'only' a continued reduction in measles-related mortality.

One reason, in fairness, is that rinderpest efforts started earlier: the first rinderpest vaccines were grown in goats and rabbits in the 1930s, and people were used to the idea of rinderpest vaccination by the time the tissue culture-grown vaccine came along. Another is that measles is just much harder. It has a basic reproduction number (R_0; the number of secondary infections that come from a typical infected individual) of around 15, while that for rinderpest is around 5. This means that we could get away with immunisation levels of around 80% for rinderpest, but we need >95% to interrupt measles transmission, which means at least two vaccination opportunities per individual. There continue to be gaps in vaccination coverage in different regions, whether because of socio-political problems with local distribution (by which I mean war and terrorism) or media-induced fear of the vaccine.

Nonetheless, there have been no scientific barriers to measles eradication since the vaccine was introduced. The same could be said of polio, where the main hindrances to eradication have again been socio-political. Perhaps, for these and other human diseases which are biologically open to eradication, an important step will be applying a really important lesson learned in rinderpest eradication: that it only really happened when a specific date was set, a finishing line that everyone subscribed to and worked towards. It is not enough to say "We should do this", we need to say "We should do this *now*".



Pan-African rinderpest campaign (PARC) poster.

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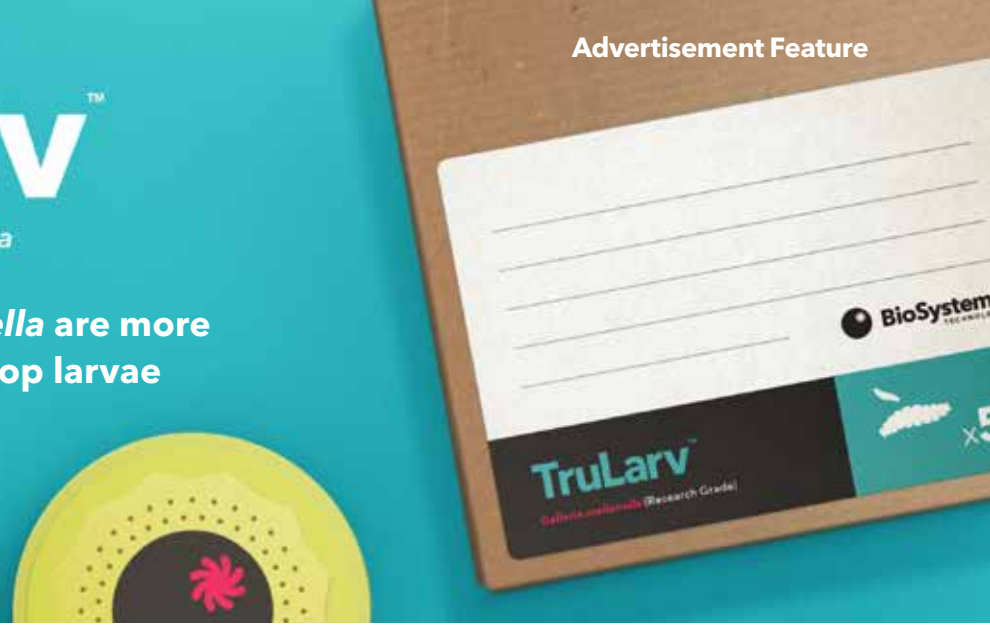

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