

MICROBIOLOGY TODAY

49:1 May 2022



Engaging Microbiology

Highlighting the importance
of teaching and outreach in
championing and advancing
the understanding of
microbiology.

Editorial

Hello and welcome to the May 2022 issue of *Microbiology Today*! The theme for this issue is 'Engaging Microbiology' and focuses on two areas – how we engage with the general public in microbiology outreach, and how we engage with our students when teaching microbiology.



As with most things over the past two years, we have all faced significant challenges in the successful delivery of outreach and/or teaching. Yet for many of us (myself included!), education and outreach are some of the most fulfilling and enjoyable aspects of our careers. In this issue, we explore some of the challenges we continue to face in higher education and hear some perspectives on the delivery of engaging outreach.

Our issue begins with a look at the evolution of learning environments and the accessibility of information in higher education. Chloe James explores the increasing use of online and digital content, which has only accelerated as a consequence of the pandemic. Chloe discusses the challenge of navigating our students through the sometimes-overwhelming volume of information and how extended reality (XR) technologies can help us to achieve this, with some wonderful examples of her own XR resources.

Next, Andrew Kirby, Jane Freeman and Alison Ledger describe the challenges faced in teaching microbiology to medical students. Despite comprehensive coverage of microbiology topics during medical education, embedding this content in a way that leads to effective recall during clinical practice remains an issue. To combat this, Kirby, Freeman and Ledger describe the development of 'GermBugs', an alternative learning strategy reliant on character-based storytelling to improve recall and student engagement.

An area of significant concern in higher education is the presence of awarding gaps between different demographic groups. James McEvoy, a member of the HUBS Bioscience Awarding Gap Network (microb.io/3JJ3elt), shows that black students and individuals from certain ethnic groups tend to be awarded worse degrees than white students and makes a case in his article for developing inclusive curricula and moving towards more active learning approaches as a way of closing this gap.

Moving away from higher education, we have our first article on microbiology outreach from Linda Oyama. Linda describes her personal experiences of science outreach as a

child before explaining how her work as a Society Champion (microbiologysociety.org/champions) allowed her to gain experience in developing her own outreach activities. Linda goes on to describe the importance of introducing children to microbiology at a young age and her passion for delivering microbiology outreach at primary schools. Indeed, it is inspiring to see that Linda has delivered outreach activities at 34 schools this academic year alone!

Continuing on the topic of outreach, we hear from microbiologists and science artists Lizah van der Aart and Eliza Wolfson about the power of art in communicating science by 'showing' instead of 'telling', and how science art can deliver memorable stories which embed scientific concepts in audiences. Indeed, in their article, Eliza and Lizah *show* you science art in action with a comic drawn specifically for *Microbiology Today*!

In our last article, Victorien Dougnon, another Society Champion, provides a fascinating perspective on his career as a microbiology academic working in Benin. Victorien describes the work he and others have carried out to overcome two specific challenges – that of delivering undergraduate and postgraduate training in microbiology, and developing the infrastructure for carrying out microbiology research in a lower-middle-income country.

We conclude the May issue with a Comment article from Mel Lacey. Titled 'Changing with the changes', Mel looks back over the COVID-19 pandemic and reflects on its impact on students and educators alike. As a teaching-focused academic, a lot of Mel's comments resonate with me very strongly. Indeed, despite the pandemic fatigue from which we are all suffering, it is an exciting time to be involved in higher education as we see the innovations developed during the pandemic become a part of the 'new normal' of our teaching practice.

Chris Randall

Editor

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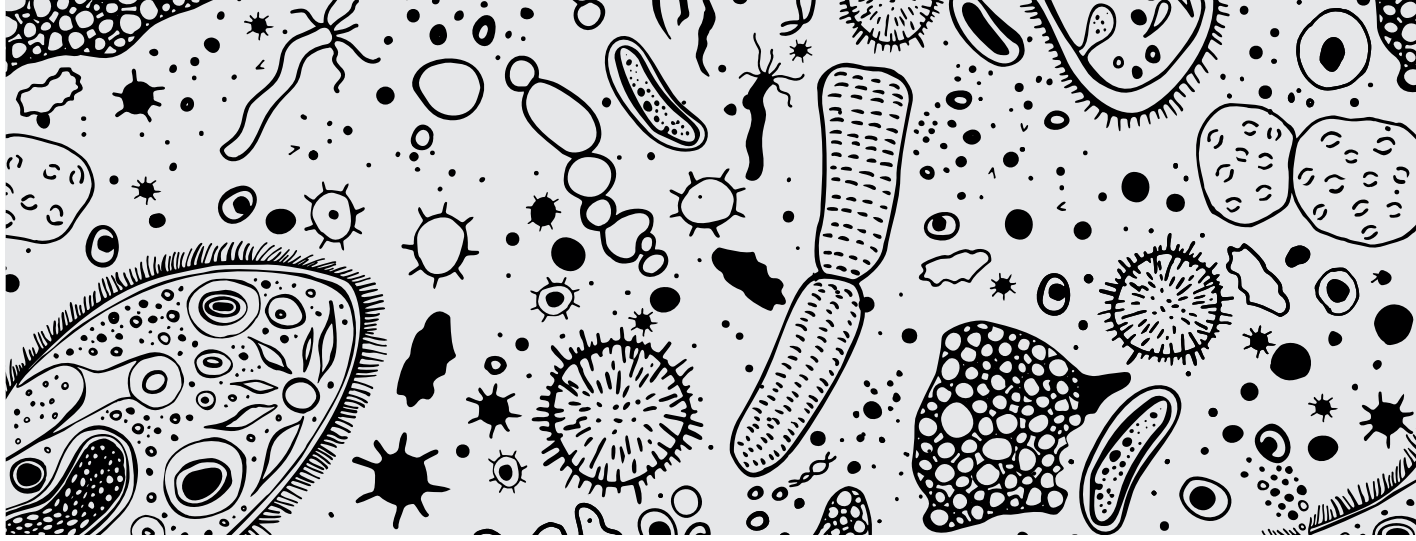
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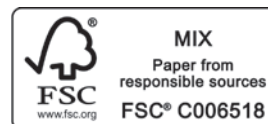
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From the President

Welcome to the May issue of *Microbiology Today* and my first issue as President of the Microbiology Society. I want to start by thanking you all for such a warm welcome to this new role, which was especially evident at the Society's Annual Conference in Belfast last month. The event provided a fantastic opportunity to meet many of you and talk about how the Society can continue to work towards its principal goal: to develop, expand and strengthen the networks available to our members so that they can generate new knowledge about microbes and ensure it is shared with other communities.



An annual conference may be over, but we have a busy programme of Focused Meetings planned for 2022, which you can read more about on page 40. These events will offer further opportunities for discussion to take place, collaborations to form and new connections to be made across our diverse community. There will also be many other events, including continuing the President's Roadshow series, as part of the Society's commitment to developing, expanding and strengthening the vast networks and opportunities available to members and local communities. I look forward to speaking to many of you at these events about your research, your interests and your ideas. The Society belongs to the members, and so we want to engage with members to understand what you need. Visit the events area of the website to find out more about the full 2022 events programme (microbiologysociety.org/events).

It's incredibly important to me that the Society supports those who are faced with challenging circumstances that have an impact on their careers. I'd like to encourage those who are in that situation to consider applying for our Unlocking Potential Grant, which is designed to help early and mid-career microbiologists to deal with circumstances that may hold them back from achieving their full potential. Recipients will be able to select elements of their support package, which will include access to trained professionals, mentors and coaches who will work to identify a way forward and provide support. The grant is supported by generous donations to the Unlocking Potential Fund, which was launched in mid-2021. You can still donate to this fund, read about why others have done so and find out more about applying for the grant (deadline 6 June) on the Society website (microbiologysociety.org/UnlockingPotentialGrant).

There are several other ways for members to get involved outside of our events and grants programme. Our Council, Committees and Divisions are absolutely essential to the work that the Society does. Together they form a cohesive network of discussion, information-sharing, collaboration and decision-making which forms our strategy and delivers quality activities. Elections for those who have been nominated for positions on the governing bodies of the Society will open later this month, so please keep an eye on your emails for details on how and when to vote, and get involved by using your vote to help shape your Society.

We are also currently inviting nominations for the Microbiology Society Prize Lectures, awarded in to recognise significant contributions to microbiology. The awards acknowledge the potential of microbiology research and champion the contributions made by microbiologists and their work in addressing global challenges. The Society is committed to creating and encouraging a diverse and inclusive culture within our membership and the microbiology community, so please consider the full breadth of the field when making nominations. Submit your nomination by 26 May 2022: more details are available on the Society website (microbiologysociety.org/PrizeLectures).

I am looking forward to talking to many of you at events and through other activities in the coming months, to understand and improve what the Society can do for you.

Gurdyal Besra

President

president@microbiologysociety.org

From the Chief Executive

A pandemic does not end with a closing ceremony. It gradually becomes relatively less important in public discourse and consciousness as other priorities seem more important. The SARS-CoV-2 virus that causes COVID-19 has not gone away, or indeed stopped being a serious problem for many individual people around the world, but at a population level we are spending dramatically less of our time and energy worrying about its immediate effects.



We can enjoy physically seeing one another again and take advantage of the kind of interaction that can only be done in person. Annual Conference 2022 in Belfast, where 1,400 members of the microbiology community came together for the first time in three years, was a wonderful way to celebrate. The amazing Prize Lectures showcased a diverse range of impactful microbiology, the brilliant poster sessions, where early career microbiologists had their first chance to tell us about their work, the workshops, social events, offered oral presentations, professional development sessions, celebratory reception for the 75th anniversary of our flagship journal *Microbiology*. These and all the other elements served to emphasise the Microbiology Society's principal goal: to develop, expand and strengthen the networks available to our members so that you can generate new knowledge about microbes and ensure that it is shared with other communities.

As we look forward to a host of other in-person events throughout the year – Focused Meetings, the Early Career Microbiologists' Forum Summer Conference, the Sir Howard Dalton Young Microbiologist of the Year finals and the Society's showcase event – I know that we will all value those opportunities to share, communicate and enjoy friendship and science. I am particularly looking forward to the Focused Meeting on Protein Secretion at the Host-Pathogen Interface in Belfast in November, because it will celebrate 50 years of the Irish Division, a world-class example of a supportive and ambitious community.

But as we come out of the initial grip of the pandemic, unsure whether the virus will show a resurgence when conditions change or a new variant emerges, microbiologists must not lose sight of what we have learned over the last two years. Among several other requests, way back in the autumn of 2020, the UK government asked us to rapidly bring together (via Zoom, obviously) experts from various institutions in the

English Midlands. Ministers and civil servants were trying to establish what became the Rosalind Franklin Laboratory in Leamington Spa. We convened a group of members who gave their time and expertise, which I hope was helpful. They did not necessarily agree with everything that was planned, but they did everything they were able to make sure it would work as well as it possibly could. Recently, when I was in Leicester with the President, Del Besra, for his first Roadshow event, I was lucky enough to meet a scientist who is working in the Rosalind Franklin Lab, and it was good to see the final outcome that had developed from the Microbiology Society's contribution all those months ago.

We do not know when it will come or what it will be, but there will be another pandemic and the world will once again look to the microbiology community for answers. No doubt the UK government will once again ask the Microbiology Society to help find some of the expertise it needs.

If I have learned anything over the last two years, it is how strong the microbiology community is, with a real sense of identity, a willingness to support one another, and a passionate desire to ensure that expertise is communicated and applied for the public good. In doing so, a key factor in success is how microbiologists in universities, industry, government service and hospitals have worked together, each group bringing different strengths to the table. The Microbiology Society's founders recognised the value that comes from bringing together a diverse range of scientists from different sectors and disciplines. That broad diversity, reflected in the Microbiology Society's current membership, will remain one of our great strengths in the coming years.

Peter Cotgreave

Chief Executive

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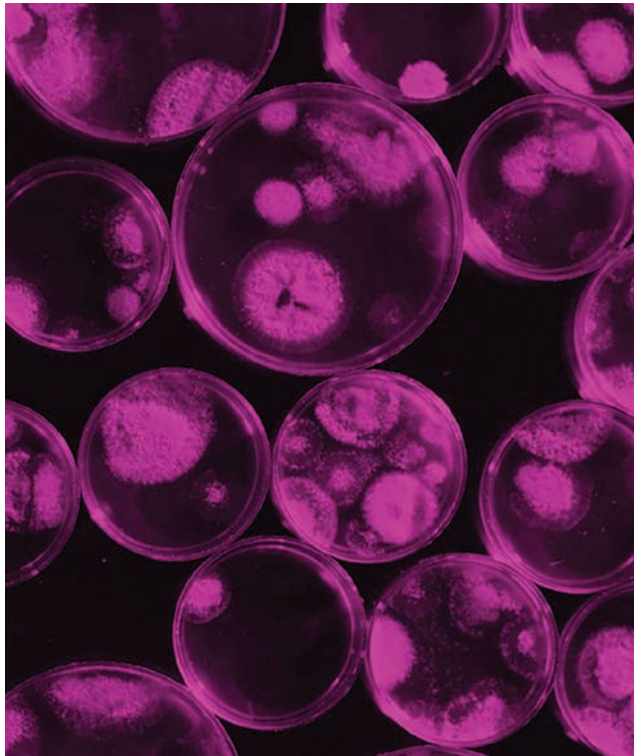
News

Launching our new open research platform

This month sees the launch of *Access Microbiology* as an open research platform. The new platform will allow authors to post versioned preprints throughout the process of submission, allowing readers to see the full peer-review process and different versions of the manuscript as it makes its way through assessment. If the article is eventually accepted, the published Version of Record will live on the same page, so readers will be able to see the entire publication process from start to finish. Each version will be individually accessible, while readers will always be informed if there is a new version available; the reviews will also be citable with their own DOI.

With open peer review and the inclusion of automated manuscript review tools, it is a great step forward in transparency in publishing – please take a look and consider submitting your papers today (microbiologyresearch.org/submit-an-article).

There is no cost to submitting a paper in the first year of operation, and we are accepting a wide variety of article types – including case reports, pedagogical practices, study protocols and much more.



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75th anniversary of *Microbiology*

This year marks 75 years of our founding journal, *Microbiology*, and 75 years of publishing for the community. Activities celebrating the anniversary will span the full year, and we are thrilled to have launched our first two themed collections:

- The Fungal Spotlight: Host-Associated Microbiomes (microb.io/3BBYHne) collection brings together fungal microbiology research from across our portfolio, and we welcome submissions to any of the participating journals.
- Guest edited by Tracy Palmer and Yinka Somorin, the Bacterial Cell Envelopes (microb.io/37NT3Py) collection brings together a series of Reviews that highlight some of the most important areas of current research in this field. Keep an eye out for our upcoming collections on cell-to-cell communication and microbial evolution in line with our Focused Meetings.

During the anniversary year, we are celebrating our past as well as looking forward to our Open Access future. The journal is pleased to have published its first historical article which looks at the origins of *Microbiology*. Learn more on pages 46 and 48.

Thank you to everyone who has supported *Microbiology* so far. The Microbiology Society is a not-for-profit publisher, publishing for the community, and all journals' income is invested back into the Society. We welcome you to get involved with our upcoming activities and support your community – join us on our journey and influence the future of *Microbiology*.

News

Microbiologists' perspectives of the COVID-19 pandemic.

Microbiology is at the centre of our learning about emerging infectious diseases. Since the beginning of the COVID-19 pandemic, microbiologists have been working tirelessly to understand SARS-CoV-2 and its implications on public health – to understand the virus at a molecular and clinical level, and develop diagnostics, treatments and vaccines.

The Microbiology Society's vibrant community of microbiologists have been amongst those on the frontline battling the novel coronavirus to protect the public and communicate their findings to the general public. We are excited to give our members a platform to share their stories of how they responded to SARS-CoV-2 through a series of case studies. Head to our SARS-CoV-2 and COVID-19 Hub (microbiologysociety.org/COVID19hub) to read about the highs, lows and everything in between of the extraordinary challenge of being a scientist in the midst of a pandemic.

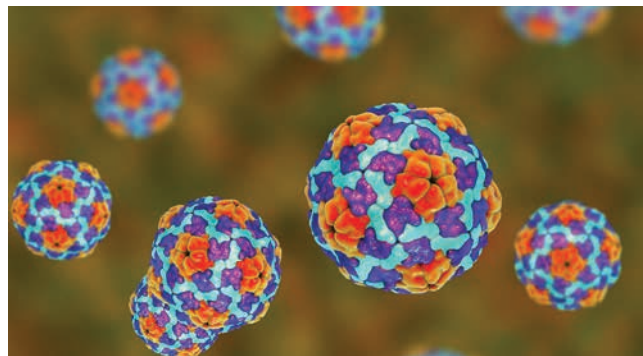


Panorama Images/Stock



New grant: Unlocking Potential Grant

We have launched the Unlocking Potential Grant, helping early and mid-career microbiologists to deal with circumstances that may hold them back from achieving their full potential. The grant is supported by generous donations to the Unlocking Potential Fund, launched in mid-2021. Learn more about the grant and apply online at microbiologysociety.org/UnlockingPotentialGrant.



Dr_Microbef/Stock

Europic 2022

The Microbiology Society is delighted to be hosting Europic 2022, the world premier virology conference that focuses on studies of picornaviruses. This family of important human and animal pathogens includes enteroviruses (e.g. poliovirus, rhinoviruses, EV-A71, EV-D68), hepatitis A virus and foot-and-mouth disease virus, as well as many other viruses whose number is growing by the day with new discoveries.

The event will take place in the picturesque spa town of Harrogate, UK, from 5 to 9 June 2022 and will provide a vital forum for the international community to come together to hear about the latest advancements in the field of picornaviruses and enjoy numerous networking opportunities to help strengthen relationships within the scientific community. Visit microbiologysociety.org/Europic2022 to find out more and for your final chance to register.

News

Find your local Champion

Do you know your local Champion? You can find out more about Champions' activities on page 53 and find out who your local representatives are on our website (microb.io/3wZTz7l).



Professor Allan Hamilton (1936–2021)

Professor Allan Hamilton FRSE, the first holder of the established Chair of Microbiology at the University of Aberdeen, UK, and a former Treasurer for the Society (1992–1998), died in Glasgow in early December. His inspirational achievements and contributions to microbiology are highlighted by his colleagues (microb.io/3JgfJEK).



Getty Images

Connect with the Microbiology Society on social media:



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@microbiosoc



Grant deadlines

We offer many different grants to support the career development of our members – including travel support, caring costs, funds to support public engagement and summer studentships. Find out more about upcoming deadlines on our website at microbiologysociety.org/GrantDeadlines.

Professor Derek Smith (1928–2021)

Professor Derek Smith, an Editor-in-Chief of the *Journal of General Microbiology* (JGM, now *Microbiology*), a former Council member, and the last Head of the Department of Genetics at the University of Birmingham, UK, died last year on 5 December. He is remembered with great fondness and respect by many colleagues and former students (microb.io/3FIPJGW).



Cathy Smith

News



Call for 2023 Focused Meeting proposals

The Society organises a varied programme of Focused Meetings each year, with an aim to bring together those with shared scientific and clinical interests to shape the future of microbiology, strengthen membership networks and enable knowledge exchange.

All members of the Society are welcome to submit a Focused Meeting proposal covering any area of microbiology. If approved for inclusion in the Society's events programme, the meeting will be delivered in collaboration with the organising committee, who will lead on the scientific aspects, and the Society's Conference and Events team, who will provide full secretarial support and manage all logistical and operational aspects.

We're currently seeking proposals for the Society's 2023 Focused Meetings programme, and the deadline to submit is 9 June 2022. Find out more at microbiologysociety.org/events or email us at conferences@microbiologysociety.org if you wish to discuss your idea for a meeting proposal.



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FIS/HIS International 2022

We are thrilled to invite you to join the Healthcare Infection Society, the British Infection Association and the Microbiology Society at FIS/HIS International 2022. The event will be hosted by the Healthcare Infection Society and will take place on 22 and 23 September in London and 26 September online.

The 3-day, extensive programme features over 35 sessions focusing on infection science, including 3 sessions hosted by the Microbiology Society:

- Disinfection in clinical practice
- Translating outcomes from infection science research to policy
- New treatment regimens for antimicrobial resistant infections

Full details about the event can be found on the FIS conference website (fisconference.org).



New career development funding available through the Unlocking Potential Grant

The Unlocking Potential Grant is now available to early and mid-career members to help them deal with circumstances that threaten to hold them back from achieving what they could. Each grant will be of the value of up to £5,000 per person, as part of a bespoke package or 'toolkit' for career development.



As a bespoke grant, the support package offered will be tailored to the individual applicant based on their needs. Often, individuals get stuck when faced with an unfamiliar problem or challenge. Recipients will be able to select elements of their support package, which will include access to trained professionals, mentors and coaches who will work to identify a way forward and provide support. Each recipient will be able to choose up to two elements from five options: career coaching, a mentoring programme, life coaching, a leadership course or a bespoke support option identified via the application that does not fit with the previous options, for example funding to visit a collaborator. All Unlocking Potential Grant recipients will also join a virtual group to meet each other and form a peer support network.

We have partnered with industry-leading organisations and providers to deliver the modules of the toolkit. These



Sarah Blackford



partners include the UK Chapter of the International Coaching Federation to provide life coaching, EMBO Solutions, which provides world-class laboratory leadership training, and Sarah Blackford, a leading biosciences careers consultant.

Postgraduate, Full Concessionary and Full Members who are early or mid-career, working in any sector, or on a career break with a strong case for support within the remit of the grant will be eligible for funding.

To apply for the grant, please see the website (microbiologysociety.org/UnlockingPotentialGrant) and apply before 6 June 2022. Contact grants@microbiologysociety.org for queries.

Inspired to support our early and mid-career members?
Why not donate today?

microbiologysociety.org/UnlockingPotentialFund

Extended reality: new frontiers of microbiology teaching

Chloe James

The ever-evolving landscape of education is going through a sonic boom of change. The floodgates are opening on information access, demands for online content are through the roof, student cohorts are more diverse than ever before and the metaverse has landed. There is an increasing need for alternative learning strategies, and immersive technologies are set to revolutionise the field of education.

Help! Is my textbook dead? – Riding the new wave of information

Students often report feeling overwhelmed by the volume of freely available scientific information online, and now pre-print platforms and plan S promise unlimited open access to all. Though the open sharing of science should be celebrated, it is our job as teaching and learning practitioners to help navigate this tidal wave with new and interesting ways to promote engagement. Higher education methods long ago shifted priorities from delivering 'facts', to encouraging independent enquiry. We strive to inspire those eureka moments when a threshold concept is grasped. This is supported by signposting to trusted textbooks for rooting fundamental knowledge. However, student communities and needs have changed too, with a diversity of backgrounds, responsibilities and priorities. The COVID-19 pandemic has acted as a catalyst for improving online learning content as modern students see a much more digital learning space emerging. This has opened an opportunity to explore the use of extended reality technologies in our teaching.

Moving microbiology into the metaverse

Recent advances in computing power and technology have launched a whole new universe of possibilities in extended reality (XR). The games industry has developed the tech to create alternative worlds such as Virbela and Spatial, and



Teaching biofilms in AR. UoS technical services at Media City, UK



even game platforms like Fortnite have been used for learning experiences, which allow users to re-invent themselves and enter the classroom as a different person. Previously, the necessary kit was expensive and exclusive; but the rapid consumerisation of XR has changed this, and there is an opportunity to develop more educational content for the equipment that is already beginning to gather dust in some family homes.

What is XR?

Extended reality (XR) is an umbrella term encompassing 'virtual reality' (VR), which is an enclosed, headset-powered, immersive digital environment, 'augmented reality' (AR), which uses projections or screens to superimpose virtual objects onto physical objects for interaction in a real space, and 'mixed reality' (MR), which is a hybrid of the two, combining both digital and real-world interactions.

This year marks a decade since my appointment as a lecturer at the University of Salford. During this time, I've had the chance to explore my creative side in the development of SciArt and interactive microbiology activities. Through this work, I've got to know an enthusiastic community of creative and digital technology practitioners and learned how XR can tap into young interests and promote a different way of engaging with course content. As microbiologists, we have the privilege of glimpsing the invisible world of micro-organisms that others are not privy to. Although I don't stare down a microscope all day, or have bionic microscope eyes, my research training and experiences mean that I have pictures in my mind that help me think about how bacterial communities grow and develop and interact with their surroundings. These concepts can be quite alien to others. The beauty of XR is that it can take you to places you would never normally dream to reach, like the Moon or the bottom of the ocean, or the microscopic surface of a cell from the perspective of a



Evaluating VR-biofilm experience. Chloe James

We can better visualise what we talked about in class.

Can visualise beyond words.

Student quotes

virus! I jumped at the chance to work with a multidisciplinary team to build virtual microbial worlds, which we called 'The MICROBIHOME'.

The MICROBIHOME (hub.salford.ac.uk/microbihome) is a suite of activities first developed for the Manchester Science Festival in 2018, but has grown as an invaluable teaching resource and primer for conversations and research collaborations. Our flagship exhibit was 'Gut Feelings', an interactive AR experience of the healthy human gut using projections and soft sculpture in our digital performance lab at Media City, UK. We brought our second-year Human Biology and Infectious Diseases students into the installation for a lecture on biofilms, which was brought to life by giant microcolonies complete with tactile exopolysaccharide matrix and cavernous channels. The students valued the shared learning space outside of a lecture format and agreed that it helped them to visualise the concepts and make connections between different aspects of their course. It gave them a thirst for more.

Gamifying the curriculum

Although the 'Gut Feelings' exhibit was a big hit with students and visitors, the set-up was time consuming and it couldn't

Clearer, better understanding 'cos we can see it happening; better than PowerPoint.

Really enjoyed it – worth coming.

Student quotes

be used as a permanent installation. The medium of VR is more sustainable and portable. With this in mind, we created a VR biofilm from a confocal microscope image of a real *Pseudomonas aeruginosa* biofilm on a glass coverslip. This was rendered, pixel by pixel, into a programme called UNITY to create a virtual microbial landscape. We then filmed our microbiology lab with a 360° camera to create a virtual lab that was stitched into the program to create the illusion that the user is performing a biofilm experiment in the lab.

It helps us visualise the concept so it sticks in our memory.

Student quote

This is so much better than a textbook; more teaching should be like this!

Parent quote

Once our virtual biofilm was built, we could layer on a narrative, in which the user zooms down to microscopic size to learn about the biofilm structure up close. We went one step further with this prototype, to gamify the concept. The user selects different antibiotics and doses in an attempt to destroy the biofilm. The experience was designed as an engaging way to demonstrate how incorrect antibiotic use can drive the development of antimicrobial resistance. The value of games and competition to promote deeper active learning is well established. This approach targeted a young audience (13- to 26-year-olds) but is also proving useful for engagement with clinical professionals and patients.

Enhancing social healthcare experiences for isolated patients

The VR-Biofilms experience is based on chronic bacterial lung infections of patients with cystic fibrosis (CF). Feedback from clinicians and parents of children with CF has highlighted

The game aspect will help students engage for longer.

Parent quote

This will aid conversations about antimicrobial stewardship.

Hospital lab manager quote

a special need for young people with CF, who can often feel isolated as they are not able to socialise together for risk of transmitting infection. The challenges of isolation have been keenly felt by all during the COVID-19 pandemic. VR applications could help to bring isolated communities together in a virtual world to share their experiences and understand more about their disease and medication. We are currently developing a virtual lung for a new XR exhibit called Microbial Puppet Masters (scicomm.space/rs22) that will be showcased at The Royal Society Summer Science Exhibition (royalsociety.org/science-events-and-lectures/2022/summer-science-exhibition/all-exhibits). This time, we are focusing on bacteriophages and the different ways that they interact with bacteria. It aims to enhance understanding about phage therapy, but also how phages can change the biology of bacterial hosts.

Is XR sustainable as a learning tool?

We have used VR biofilms on mobile phones connected to VR headsets in teaching and at science festivals and stakeholder events. VR experiences can be downloaded onto personal mobile phones to be viewed via an individually owned kit that can vary from high tech and fully immersive to simple cardboard headsets. This format is becoming more widely accessible and has the potential for large-scale impact on populations that could not otherwise have access.

I believe that experiences like this can nurture multi-disciplinary thinking and inspire the next generation of scientists to think outside the box in tackling global challenges like antimicrobial resistance. The technology is moving fast, and there is a real demand for more interdisciplinary collaborations to develop sustainable educational XR suites that can adapt and evolve as both microbiology and technology move forward. Of course, the future of higher education should not rely on high-tech equipment alone. I see the use of XR in teaching as a primer for deeper enquiry and learning, and it is important to build discussion points and further resources around the experience.

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Chloe currently works as a senior lecturer in medical microbiology at the University of Salford. Her main research interests are in bacterial pathogens. Her latest work aims to better understand how temperate bacteriophages interact with their bacterial hosts. Active in science communication and public engagement, Chloe has developed a range of activities to increase public awareness and understanding of the microbial world. She is interested in how immersive technologies, art and public engagement can enhance learning about microbiology. The next event explores phage–bacteria interactions in microbial communities of a virtual reality lung and will be showcased at The Royal Society Summer Science Exhibition this July.

What inspired you to become a microbiologist?

My mum told me about the trips that our next-door neighbour went on – collecting weird and wonderful samples to understand more about how diseases spread. I found this absolutely thrilling and wanted to know more.

What do you love most about your job?

I love the variety of my job. No two days are ever the same. I get to talk with all kinds of people about the invisible world that fascinates me. I learn something new every day and immediately want to share it with someone else.

The GermBugs collaboration: story-based microbiology teaching to engage and inspire undergraduate medical students

Andrew Kirby, Jane Freeman and Alison Ledger

With 30% of patients in hospital on antibiotics, training medical students in medical microbiology is important. However, the time available for microbiology teaching within undergraduate curricula has been squeezed from a time when students experienced rich learning in microbiology laboratories to being taught by experts in lectures. Despite comprehensive curricula, students have reported not remembering lecture-based teaching in subsequent years. Furthermore, microbiology is a subject that is often entirely new to students and, being heavy on new Greek and Latin terminology, can be difficult for students to access. We believe some students may learn microbiology better from alternative learning opportunities.

Based on our experience as parents who read children's stories, and as doctors, where we commonly personify pathogens, e.g. we battle nasty bugs, we recognised that bacteria could easily be transformed into story characters. We knew from previous medical education research that stories can be memorable, provide scaffolding and reflect ways that humans have always learned. Therefore, we developed stories about bacterial organisms, called the GermBugs. We invited medical students, art graduates and learning technologists to join us in co-developing the GermBugs to make microbiology learning more engaging and accessible. The GermBugs resource is an online, interactive, audio-visual resource with varying levels of complexity which is suitable for independent learning. We evaluated medical students' experiences of the GermBugs prior to it being implemented this academic year. This article tells the story of the GermBugs development process so far, including obstacles and learning along the way, as summarised in Figure 1.

Year one – Development

We designed a GermBug story for the bacteria *Staphylococcus aureus* based on a character called the Green Explorer, who is

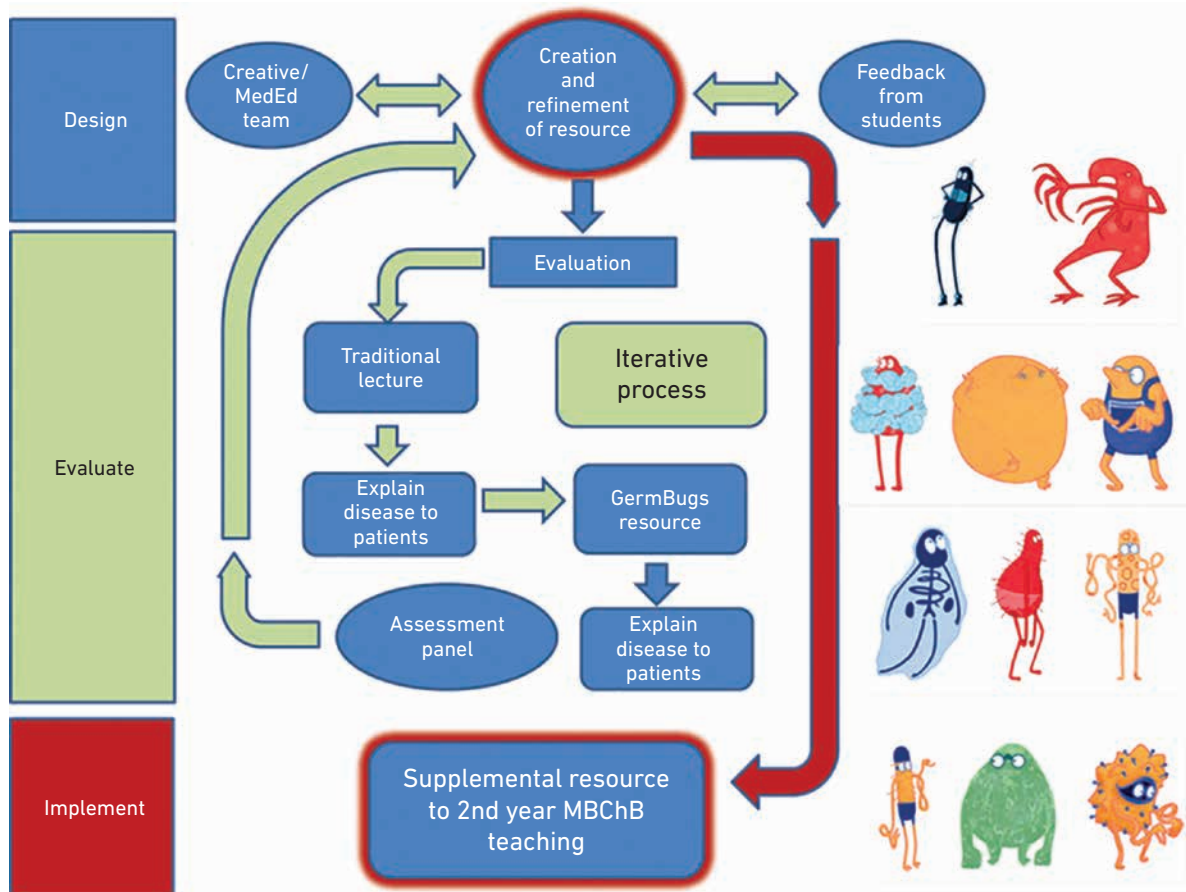
green given all that snot in the nose (perhaps you knew *S. aureus* lives in the nose already, but hopefully you'll remember more easily now). In the story, the Green Explorer is picked from the nose and put down in an open wound where an infection follows, as shown in the picture on page 18.

We presented the story to a small group of medical students for feedback. Most resisted the resource, anticipating that other medical students would find the illustrated story patronising. While some students recognised some potential in the resource, they were focused on how it would relate to their pass or fail examinations. Only one student, then in their final year, saw potential in the resource to give language which could aid communication with patients. Frustrated that our new resource was not wholeheartedly welcomed, we decided we needed to learn more.

We recruited two intercalating medical education students to undertake more detailed research about learning through the Green Explorer. One student (Priyanka Gandhi) sought to test whether the Green Explorer led to improved microbiology knowledge, while the other student (Muhammad Noor) explored what influenced first-year students' reactions to the Green Explorer.

Through the first study, we learned that administering a multi-choice question assessment after reading about the Green Explorer may not have tested what the resource had taught above lecture-based teachings, such as understanding infection processes. The second study further enhanced our understanding of the earlier group's reactions. The Green Explorer was most valued by students who had previously used the arts to enhance their learning. Other students had relied on memorisation of facts and 'past papers' and expected to continue learning in this way at medical school. Learning through stories did not fit these students' expectations of discipline, formality and 'seriousness' in medicine. Students

Figure 1. ©Imogen Fancourt



also fed back to us that they would engage with the Green Explorer only if it related to a formal learning objective and exam questions were based on the content. They also suggested the story should be given alongside traditional resources, to supplement but not replace traditional lecture-based education.

This research led us to think more carefully about how the GermBugs should be introduced to students.

Establishing its credibility and clinical relevance was the next challenge.

Year two – Pilot and Evaluation

The following year, we had the opportunity to work with another intercalating medical education student, Lucy Pangbourne, to trial an improved GermBugs resource. This time we recruited clinical medical students from years 3–5 to try out the Green Explorer and apply it to patient-based scenarios about infection.

First, students accessed a traditional-style recorded lecture on *S. aureus* and were then asked to explain aspects of the process of infection to a patient. Second, they were invited to engage with the Green Explorer and explain the process of infection to a different patient. Students were then invited to compare the two experiences. The students' explanations were recorded and later assessed by the

student researcher, a consultant microbiologist and patients for clarity, accessibility and accuracy.

All agreed that students showed greater fluency and confidence when explaining infection after working through the Green Explorer. One student reflected, "After doing the ... interactive learning, I definitely felt like I was more confident explaining [...] the whole infectious process", while another explained, "the stepwise approach with the same storyline, that was quite helpful". The students conveyed a better understanding of the sequence of events and used the language and metaphor of the story, with the consultant noting "I can see the science and story info merging". This addition was valued by the patients, one of whom reflected "if the doctor is sharing it with me like that, I'd be able to pass it on". Though the consultant and patients were not informed which explanations were given after the Green Explorer, they could tell due to the adoption of language from the story.

Presenting the Green Explorer in relation to patient-based scenarios appeared to aid students in understanding the clinical relevance and value of learning through story, evident in the following quote: "I liked the pictures [...] it helped me when explaining to a patient [...] you just have to kind of say what you've seen". This was a critical lesson for us when developing the GermBugs for implementation this year.

Year three – Implementation

The GermBugs resource is available online for students across the UK to supplement their learning (time.leeds.ac.uk/resources/germ-bugs). This resource features the case-based scenario previously described, allowing other students to compare GermBugs to traditional resources. In total, 10 GermBug stories including Badu the Bacteroides and Harry the Haemophilus (as shown in the pictures) have been created which educate on bacterial pathogens, the transmission of infection, diagnosis and treatment approaches.

The GermBugs resource is being introduced to second-year medical students in a tutorial this semester and they will be encouraged to use it beyond the tutorial to enhance and reinforce learning. We have, as advised, assigned formal learning objectives related to the resource and added questions to the end of year exam to achieve curriculum

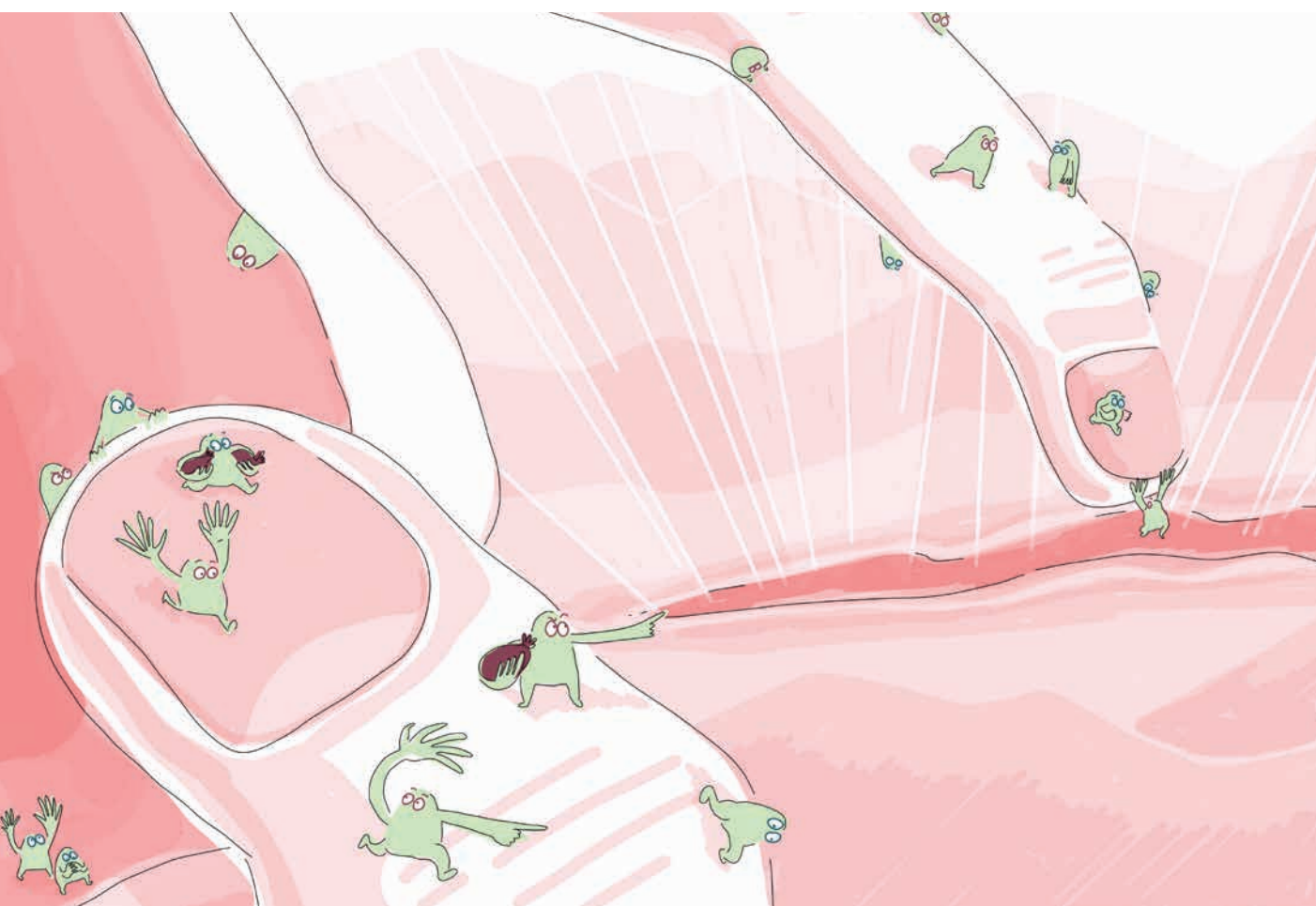
alignment and further convey the GermBugs' value. This will allow further evaluation.

Conclusion

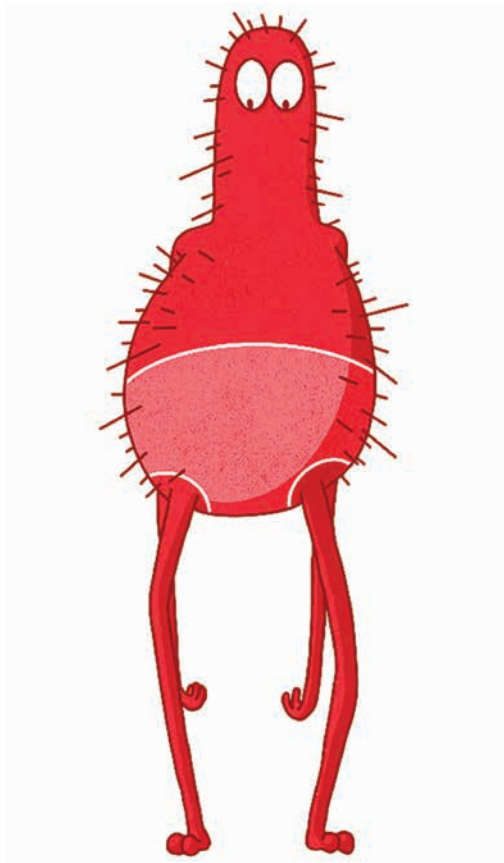
Looking back on the story so far, we are proud to have developed a microbiology teaching resource that is engaging and informed by contributions from students and colleagues with expertise in visual and digital communication. Based on our positive experience, we recommend others engage in collaborative processes when developing microbiology resources and hope we have inspired you to undertake similar co-design work. We look forward to sharing further findings from the implementation phase – stay tuned!

Acknowledgements

We would like to acknowledge members of the GermBug collaboration in developing the GermBugs resource: Sue



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Bickerdike and Charlotte Holmes: Learning technologists;
Imogen Fancourt: Artist; Priyanka Gandhi, Muhammad Noor
and Lucy Pangbourne: Medical students.

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Drs Kirby, Freeman and Ledger are based at the University of Leeds and are involved in medical student education. They have co-led the development of the GermBugs resource by contributing their clinical, educational and scientific expertise to the project.

Why does microbiology matter?

Andrew: Microbiology matters because effective control of microbial pathogens keeps us safe from serious infections, and lets us all develop our potential.

What do you love most about your job?

Andrew: Academic microbiology gives the opportunity to develop projects over the long term. A longer-term approach gives the time to work with colleagues and create impactful interventions, be them clinical or educational.

Degree awarding gaps in the biosciences

James P. McEvoy

Does each undergraduate student get the degree they deserve? The answer is important not only for students and universities, but also for employers who expect someone's degree classification to reflect their aptitude for work. The evidence unfortunately shows that some kinds of undergraduate students are awarded worse degrees than one would expect, given their entry qualifications.

That last qualifier is important. We might expect students who had received 3 Ds at A-level to be awarded worse degrees than those who had arrived at the same university with 4 A*s. After all, if there were no correlation between pre- and post-entry performance then universities would not set entry grade requirements for their courses. There is some correlation, though, so it makes sense to compare graduates who began their degree course with similar entry qualifications.

When we do this, we find that non-white students, and particularly black students, tend to be awarded worse university degrees than their white peers. We also find these 'awarding gaps' (also known as 'attainment' or 'achievement' gaps, particularly when referring to individual assessments or modules) among students from educationally disadvantaged backgrounds, disabled students and male students. Awarding gaps in the UK are usually expressed by measuring the percentage of students in a particular group who are awarded a first or upper second-class degree and comparing this percentage with a reference group. Data from 2020, for instance, show an average awarding gap of six percentage points for Black, Asian and minority ethnic (BAME) students compared with white students across ten UCAS entry tariff ranges, from around 48 points (equivalent to 1 A grade at A-level) to 207 points (roughly 3 A*s and a B at A-level). The gaps are even bigger among students who enter university without A-levels.

Awarding gaps are seen in all subjects. Although they are somewhat smaller in mathematical and scientific disciplines than in other fields, this comparison masks large variations between different subjects and different ethnic

groups. The BAME awarding gap in the biological sciences was 11 percentage points in 2020. Although this value was not corrected for entry qualifications, doing so would not make it disappear; children from most ethnic minority groups, including black children, do better at school than their white peers. Why is this pattern reversed when they get to university?

This question is hard and can arouse political controversy, especially when it comes to ethnic group awarding gaps. Conservatives may argue that the reasons are found in the students' cultural environment (e.g. the advice they receive on their degree and university choice) while those on the left often emphasize deficiencies in the university environment (e.g. racial discrimination on campus). Other demographic attainment gaps attract less attention but are no smaller: the male/female awarding gap in the biological sciences, for example, is as big as the BAME/white awarding gap. Empirically minded biologists may feel that debating the causes of these gaps is less urgent than deciding, based on evidence, how they can best be reduced.

In the classroom, university science educators can reduce demographic attainment gaps by engaging students in 'active learning' rather than by asking them to absorb knowledge from a traditional lecture. Active learning can involve problem-based learning, peer teaching, discussion groups, quizzes, or anything else that asks students to use and reinforce what they have learned. If the students have prepared for the class by reading, engaging with online materials and taking a pre-class quiz then the classroom has been 'flipped': students meet new material independently and extend their learning in class, rather than learning the content in the lecture and practising their skills afterwards. Using class time for active learning bears fruit for all students but particularly, it seems, for those on the wrong side of many awarding gaps. An educational group based in the Department of Biology at the University of Washington in Seattle has proposed the 'heads and hearts' hypothesis to explain why this is so. On the 'heads'



AnnaStills/Stock



side, demographically disadvantaged students might benefit from active learning because it supports their development of the advanced cognitive skills which distinguish higher education from high school. A student from an educationally disadvantaged background, for instance, can develop their problem-solving skills in structured and scaffolded classroom activities, whereas an advantaged student might start their course with a better idea of how to extrapolate those skills from traditional lectures. On the 'hearts' side of the hypothesis, students who are in a demographic minority might gain disproportionate benefit from the social side of active learning, gaining confidence and feeling included in a shared educational experience. Classroom activity that invites participation from all learners builds a community that boosts the performance of students who would otherwise feel out of place.

Interventions at the department and faculty level have also proved valuable in reducing awarding gaps. Mentoring, for instance, and other kinds of counselling, coaching and role-modelling activities are all linked to better outcomes for students. The most common scheme of this type is peer-mentoring, in which a more experienced student mentors a less experienced one. Some of the best evidence for the effectiveness of this approach in the UK comes from a 2014 study that measured the effect of peer mentoring on two matched cohorts of first-year undergraduate psychology students. Compared with unmentored students, mentored students felt they were more integrated into university life and were less likely to say that they wanted to leave ten weeks after they started their course. Although the mentoring scheme in this study did not target disadvantaged demographic groups, schemes that do have been associated with lower drop-out rates and awarding gaps.

Degree awarding gaps are the result of a complicated mix of social and academic factors, and we cannot eliminate them with purely local measures. It is universities that have made an institutional effort, coordinating several different kinds of interventions, that have made the most gains against the gaps. An example of this kind of holistic approach is seen at Kingston University, UK. Kingston has mixed four ingredients: organisational change, student support, an inclusive curriculum and a 'value-added' metric to monitor the awarding gap. First, organisational change: universities are big institutions, and it takes focused leadership, performance indicators and targets to make the fight against awarding gaps part of the culture. Second, they have targeted academic and pastoral support for students in at-risk demographic groups, including the kind of mentoring and role-modelling schemes described above. Third, the university has developed an inclusive curriculum in which all students can recognise themselves in every course, building their sense of belonging and boosting their confidence. Finally, Kingston has a learning analytics system that can measure, analyse and report on demographic attainment gaps down to the module level, so that teachers can change their teaching and see results. Other universities have emphasized different aspects of this model, but the recipe for success is recognisable – a blend of inclusion, support and pedagogy that is good for all students, but best for those least likely to get the degree they deserve.

If you would like to find out more about tackling demographic awarding gaps in our discipline and/or share your experience of doing so, please join us in the HUBS Bioscience Awarding Gap Network (connect.advance-he.ac.uk/topics/28018/feed).



Rattankun Thongbun/iStock

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James began his academic career at the University of Oxford, UK, completing a doctorate in inorganic biochemistry. Following postdoctoral work at Yale University, James taught at Regis University (Denver, Colorado) before moving to Royal Holloway where he teaches, conducts pedagogical research and is the Head of the Department of Biological Sciences.

What advice would you give to anyone starting their academic career?

Be flexible. If you focus on disciplinary research then you will only be successful if you can change direction. You need to do what you

love, but you also need to ask yourself where funding will come from and what is feasible at your institution. If you want to focus on teaching then you will need to try out new teaching techniques, cultivate your pedagogical interests and carve out a niche for yourself. Try out new things. You won't be successful if you keep on doing the same thing.

Could you describe one of your typical work days?

If it's term time then I might be teaching in the lecture hall or laboratory, but most days I start with an hour on Outlook, because I get a lot of emails. If I can reply to an email immediately I do so, if not I create a task or make time in my calendar to deal with it. The rest of the day is for meetings with staff and students, completing tasks on my Microsoft To Do list, and working on my own projects. I try to stick to 9–5 as far as I can, but my phone makes it easy to work outside those hours if I need to.

Inspiring the next generation of microbiologists through outreach: early beginnings matter!

Linda Oyama

My earliest memory of outreach and public engagement in education was in high school in Nigeria. My biology and chemistry teachers (Mr Ashu and Mr Akpan) had selected me to facilitate science exhibit stands as part of the graduation event for leavers that year. The biology exhibit was based on building a model of the nephron and explaining its structure and function, while the chemistry exhibit showcased two phenomena, 'the burning bush' using a handkerchief and 'smoke without fire'. Although I was extremely nervous, I stood there all day that Saturday and explained my exhibit and answered questions from students, parents and other VIPs who attended the event. I still think of that memory fondly and I believe this was the beginning of a passion to inspire other young people like myself to pursue their goals and careers.

My absolute passion is education for children and young people, so I guess that is what inspires me to do outreach. As early as my high school days and as an undergraduate, I would give motivational talks to young people at numerous high schools during assemblies and offered my free time teaching free tutorials in subjects like maths, english, biology, chemistry, physics and geography. However, looking back at my childhood, I cannot remember ever meeting a scientist once, and though I had excellent science teachers in secondary school, I never saw a scientist at work and never met one who explained to me what science was about and what they did every day for a living or the impact their work had in the world. In fact, before enrolling at university for a microbiology degree, and studying to be a scientist myself, I had no real-life scientists/role models to look up to. I didn't fully understand what the subject of microbiology entailed, only that it was an allied medical science degree. You see, when I was growing up, you studied to become a doctor, lawyer, engineer or accountant or nothing, as anything else was not as prestigious.

I liked the fact we got to dress up as scientists and I enjoyed using the test tubes. I am very proud of the results I have gotten.

Pupil

Linda, thank you so much for that session this morning. It was so interesting and educational and fun all at the same time...

Teacher

I ended up in the sciences because the science subjects were the most intriguing for me and because I love a challenge. I couldn't get enough of logic, integration and differentiation, the wonders of life, the many chemical reactions of elements in nature and the world of electromagnetic waves, etc. Even though I fell into microbiology, my love for the subject continues to increase, and I am convinced that it is one of the most versatile areas of study, with endless opportunities to work in many spheres of life. I believe microbiology doesn't get the publicity it deserves.

Combining my love for microbiology and my desire to inspire and contribute to the education of young people became a reality when I first got involved in microbiology outreach as a Microbiology Society Champion. I was studying at Aberystwyth University at the time, and Dr David Whitworth mentioned that the Society Champions Scheme was kicking off. I jumped at the idea of promoting the Society through outreach, especially as we would be reaching young people and the public. He helped to look over my application to the Society for an event for Science Week and with organising and



Linda Oyama

recruiting undergraduate student volunteers to help with the activity, etc. After that, I went on to organise other successful events during Biology Week in subsequent years.

Another opportunity to be involved in outreach arose when my PhD supervisor, Professor Sharon Huws, signed up for the Soapbox Science event in Swansea in 2016. She was looking for someone to dress in a cow costume to help at the event and I volunteered. My daughter and I wore matching cow onesies and wheeled a sheep model eating fresh grass through Swansea city centre. We were undoubtedly a great spectacle with a lot of prying eyes watching us. Needless to say, our costumes drew a lot of people to the stand. This event opened my eyes to another dimension of outreach – community outreach – which was essentially communicating your science to people of all ages in a comprehensible and

“My daughter came home and told me all about it, she really enjoyed it!

Parent

Thank you so much for our workshop this week. The children really enjoyed looking at their petri dishes and designing microbes yesterday. It was GREAT!

Teacher

“I think the process was the most fun but seeing the results... was interesting. I really enjoyed it and it encouraged me to be a scientist in the future.

Pupil

relatable way. I learnt the importance of touching on how our research may impact the everyday life of the people listening to us. Thereafter, I took every opportunity I got to be involved in events of this nature, e.g. hosting a Microbiology Society stand and assisting in many events like the Royal Welsh Agricultural Show, NI Science Festival, the Balmoral Show, etc., taking inspiration and resources from many colleagues along the way.

Naturally, when I moved to Belfast in 2017, I immediately noticed the gap and opportunities for outreach. Firstly, although there were many excellent schools that my daughter could choose from, I was somewhat surprised and a little disappointed that many of their prospectuses showcased their strengths and programmes in subjects in the arts and sports, and very little was promoted in the sciences. I thought a great opportunity was being missed to inspire the love of science, and more specifically microbiology, especially as there were quite a few all-girls schools. So, I decided to start my outreach from that standpoint. For me, education (in whatever form that may be) is the most important tool a child can have. It is important to me that every child, especially the girl child,

knows that studying science is exciting as well as rewarding and that nothing is impossible to achieve. I want every child to believe that they can do anything, they can be scientists, and even better, they can be microbiologists! We can certainly achieve this, but we must start when they are young, just like theatre, instrumental and musicianship lessons are introduced at a very young age. I thought, "wouldn't it be great if a child experienced what it was like to be a scientist, and already started to think about a possible career in science, before they go to high school?"

Now, I don't mean to say that no science-related workshops and/or visits were offered in schools. Of course, slime experiments and colourful explosions are excellent for inspiring interest and exciting a young mind, but I think we must offer something more! We must make our science meaningful to young people, they must see it as a possible vocation, where they too can make an impact and a difference in the world they live in.

Consequently, the kind of outreach I deliver aims to inspire young children and youths through contact with real-life scientists using easy-to-follow, pupil-led, hands-on activities on topical and relevant topics in microbiology and science-related subjects. Through these activities, I hope to perhaps

The pupils (and staff!) really enjoyed being scientists for a wee while! We would love you to come back in at any stage to work on any area within science – it was all such a valuable experience for our pupils.

Teacher

show them the myriad of opportunities they have should they become scientists, and specifically microbiologists, and what difference they could make in their immediate community and the world at large. The Champion Scheme really gave me an excellent platform to do this work, as I was not only sharing my research but also felt proud to be representing my professional society as well as my lab group, who support me wholeheartedly in this venture.

This academic session, I opened up the schools' outreach programme I tagged 'MyScience Microbiology Champions Activity' to all primary schools in Northern Ireland, which was promoted as a case study on the STEM Ambassador NI Hub with support from the Society. This included an offering of six topics from which schools could choose. I received a tremendous response, with 66 schools signing up. So far, I have reached 35 schools (seven virtually and 28 in person), reaching 1,646 pupils in key stage 2, mostly in the final year of primary school. I have also been grateful for the opportunity



Erin Andrews



Linda Oyama

I liked how I got to dress like a scientist and swab the plates, it was really fun to do everything by myself and liked seeing all the microbes growing from the keyboard. I would like to do more experiments to know whether they were good or bad microbes...

Pupil

to train other colleagues and undergraduate and research students who have accompanied me on some school visits. We get excellent feedback from many pupils, parents and teachers alike, with many of them wanting to make it a more frequent event.

Ideally, my vision is to get tangible science, and specifically microbiology, into primary curricula, so that science is not just a one-off workshop but becomes part of their learning, preparing them for future careers. I have made some hands-on follow-along videos on topical microbiology issues which can be adapted by schools and teachers to deliver these activities themselves to pupils with input from scientists.

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Linda contributes to teaching and learning, and research excellence at Queen's University Belfast. Her research focuses on the study of microbiomes to tackle key societal challenges, including antimicrobial resistance and infectious diseases in the clinical and agricultural sectors.

Why does microbiology matter?

If we consider the phenomenal number and scale of microbial life on our planet, it is easy to see why microbiology matters. For instance, there are 100 million times as many bacteria in the oceans as there are stars in the known universe. Therefore, microbial life, albeit mostly considered a problem, and the study of microbial life (microbiology) potentially holds the answer to many scientific questions across species, habitats and planets.

What advice would you give to anyone interested in outreach work?

We are surrounded by many inspiring colleagues already doing outstanding outreach work. We see further by standing on the shoulders of giants, so take advantage of them in your quest to do the work you are passionate about. They are always willing to share insights and help.

Science art: it's all about connecting the dots

'Bacterium'. We all immediately have a vision in mind. Perhaps it's an *E. coli* with pili and flagella, maybe a *Bacillus* forming a spore, a mat of *Streptomyces* complete with aerial hyphae – or even a twirling spirochaete. A few more words will allow us all to share this same idea of 'bacterium'.

Eliza Wolfson and Lizah van der Aart

You, a reader of *Microbiology Today*, are probably lucky enough to know a lot about different bacteria and their ecology. Perhaps you have studied snapshots of their lives or even watched them move. Most people don't have the equipment or know-how to do this; bacteria are generally too small to see without specialist equipment. Yet how can you really imagine a bacterium if you have never seen one?

This is where science art, or 'sci-art', comes in. By showing, rather than telling, we can bypass the jargon of description – what do they look like? Allowing us to move on to the fun part: what are they doing? What's their story? What are their needs?

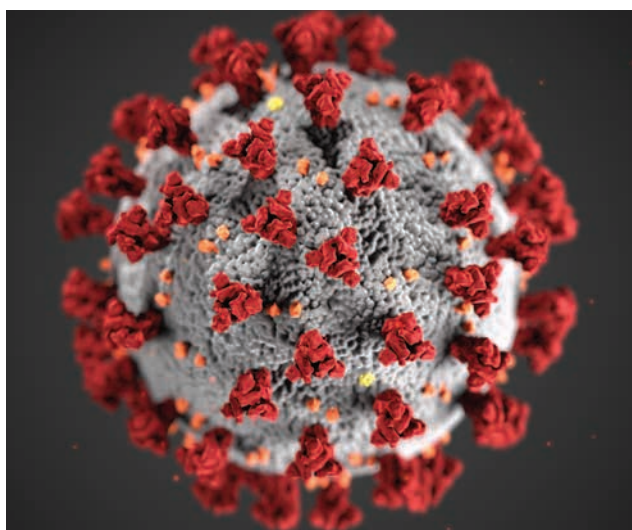
Sci-art is a great tool for telling stories about and around science, rather than just explaining the science itself. These stories can help us to explore the 'so what?'s of microbiology together, by creating a basic shared visual language. Science stories are not just made of language, visual or otherwise, but also emotion. You don't have to understand how antimicrobial resistance occurs to feel empathy for a cartoon character who is frightened by it. Adding layers of emotion through narrative can soften the blow of some of the scarier 'what if?'s, for example, with humour. All this allows us to delve deeper into how microbiology impacts the world or the people around us and connect the dots.

A wider appreciation and connecting the dots with microbiology is now more important than ever. As we live through this pandemic, we have to make decisions about microbiology every day. We weigh up the risks that different variants of an airborne virus pose to us, our loved ones and our communities, against the mitigations available to us. Again, a reader of *Microbiology Today* may have a firm basis to make those decisions. However, many people without an understanding of infection processes and control or vaccination are having to make tough calls, often in a landscape of inconsistent and ever-changing public health messaging.

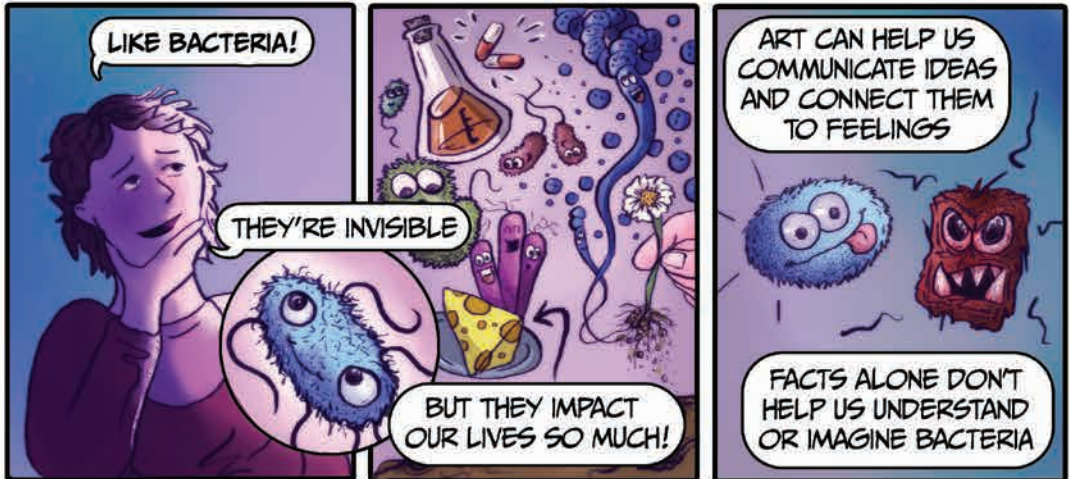
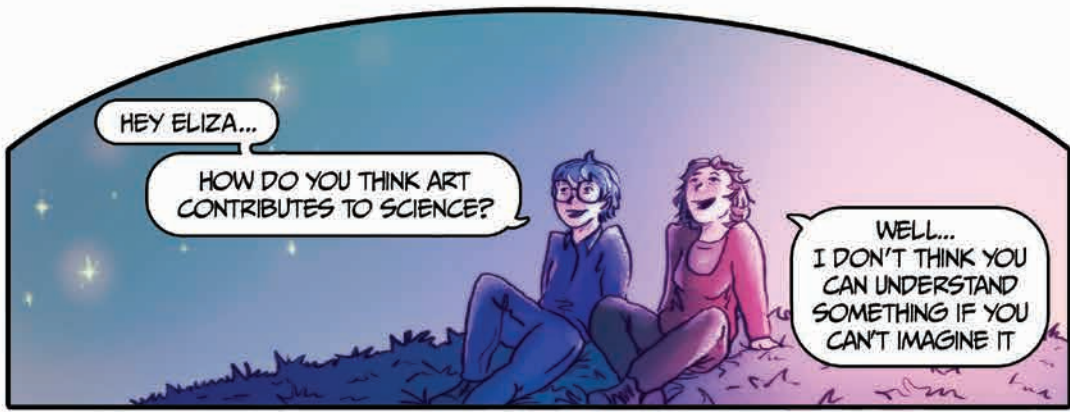
Sci-art has given people a shared picture of what SARS-CoV-2 looks like; the US Centers for Disease Control

and Prevention's familiar grey virion with red spikes is etched into the collective memory, an icon for this time and our shared danger. When talking heads discuss spike protein mutations, most people know they're talking about 'the red bits'. Sci-art has also helped share how we can protect ourselves and each other; it was no accident that early on in the pandemic there was a global call from the United Nations for art to help spread public health messages and unity. This art was about communicating emerging scientific and health information, quickly, simply and emotively.

This need to communicate microbiology more widely won't go away as we 'learn to live with' COVID-19. Another silent pandemic is growing all the time, into something that poses a real risk to our way of life (if climate change doesn't get us first): antimicrobial resistance, or AMR. It is already killing more than a million people a year and is estimated to kill ten times that in 20 years. The scale of the problem is too big to take in by looking at those cold hard numbers and too awful. Attempting to shock people into action with factual prediction appears to have the opposite of the desired effect,



Centers for Disease Control and Prevention



"CONNECT THE DOTS"

ELIZA WOLFSON AND LIZAH VAN DER AART

Excerpt from *Spiral*, a comic by Eliza Wolfson and Lizah van der Aart

as shown by how the 'global warming' discourse progressed in the 1990s. It becomes easy to dismiss the whole thing because it seems that it's too big to do anything about, and too far in the future.

A proposed solution to this problem is to approach science communication from a place of empathy, rather than facts. By showing an audience what AMR is with sci-art, we can move past boundaries like jargon. For a brief moment, the difference between antibiotics and antimicrobials doesn't matter – only that the bad guy is or isn't slain. Instead of starting with bare facts, we can use sci-art and embed them into a narrative, starting with empathy and only then moving on to the explanation once someone is receptive to it.

Sci-art not only gives us the tools to visually explain AMR but also to relate, engage and empower people around these issues. Sci-art can make AMR more relatable by using characters we can become invested in. Done well, these characters can pull us into their world. They can take us through how we might feel in the face of 'what if antimicrobials stop working?' and move past it, along their narrative arcs. By sharing characters that go through these emotions with an audience, we validate their own emotions. Also, unlike the reality of factual predictions of doom, if you don't do x, y or z, a narrative arc can build towards a resolution. This can be used to empower the audience. They can be taken through a rollercoaster of plot and emotions so that at the end they are left understanding how they feel about AMR – and perhaps even what they can do to help.

Sci-art is often not merely illustrative, but a storytelling device. The story or central concept behind sci-art is key and often determines its entire structure. This is particularly the case when using sci-art in comics. For example, when making 'Connect the dots', the first thing we did was to hone the message in the speech bubbles and work out their placement. This may seem counterintuitive, as comics appear to be all about illustrations. Yet without proper structure, pacing and word choice for the narrative, the story does not make sense. As with other versions of storytelling, sci-artists have a toolbox that they can use. Like a hook to catch the reader's eye, or leaning heavily on emotions and expressions to create drama and finally: humour – either a visual gag or a joke in the text. There is a good chance that the reader doesn't initially care about the explanation of AMR in a comic, but becomes invested in the cat that tries to get the main character's attention. Yet while enjoying this, they are creating positive associations with AMR, science and microbiology.

The real beauty of using art to communicate scientific concepts is that there are a number of technical devices that the artist can use to affect conscious and subconscious emotion, which influences how an audience engages with the science. The simple concepts of 'good' and 'bad' can be communicated implicitly by choice of colour, shape, composition and quality of line. For example, in our comic, 'Connect the dots', there is a 'good' and a 'bad' bacterium. The 'good' is easy to recognise with big googly eyes, a soft, round shape and pastel colouring. The 'bad' has sharp edges, big teeth, angular lines and blood-red colouring. We don't have to tell you which one is good or bad, you already know via these visual shortcuts. It doesn't have to stop at good, bad, happy or



sad either – emotional weighting can be applied to any scientific concept. Of course, this is not new; we are simply leaning on long-standing trends in visual storytelling. We are using the associations that existing comics, animations and illustrations have already created to tell stories about science.

In short, our goal as science artists is to help create a shared vision that we can all engage with, as it can be hard to understand what you cannot see inside your head. Perhaps this sounds superfluous – we just draw pretty pictures! However, these pictures can help shape the narrative and image of science, and how it is discussed in wider society. Sci-art is a bit like a superpower: with this tool, you can influence what someone imagines and feels when they hear this word: 'Bacterium'.

About the authors



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Lizah van der Aart

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Eliza Wolfson and Lizah van der Aart are microbiologists and science artists who occasionally team up to make comics together. They are currently working on crowdfunding a set of comic anthologies about AMR – check out [@AMR_comics](https://www.amr-comics.com) for more information!

What inspired you to work in science art?

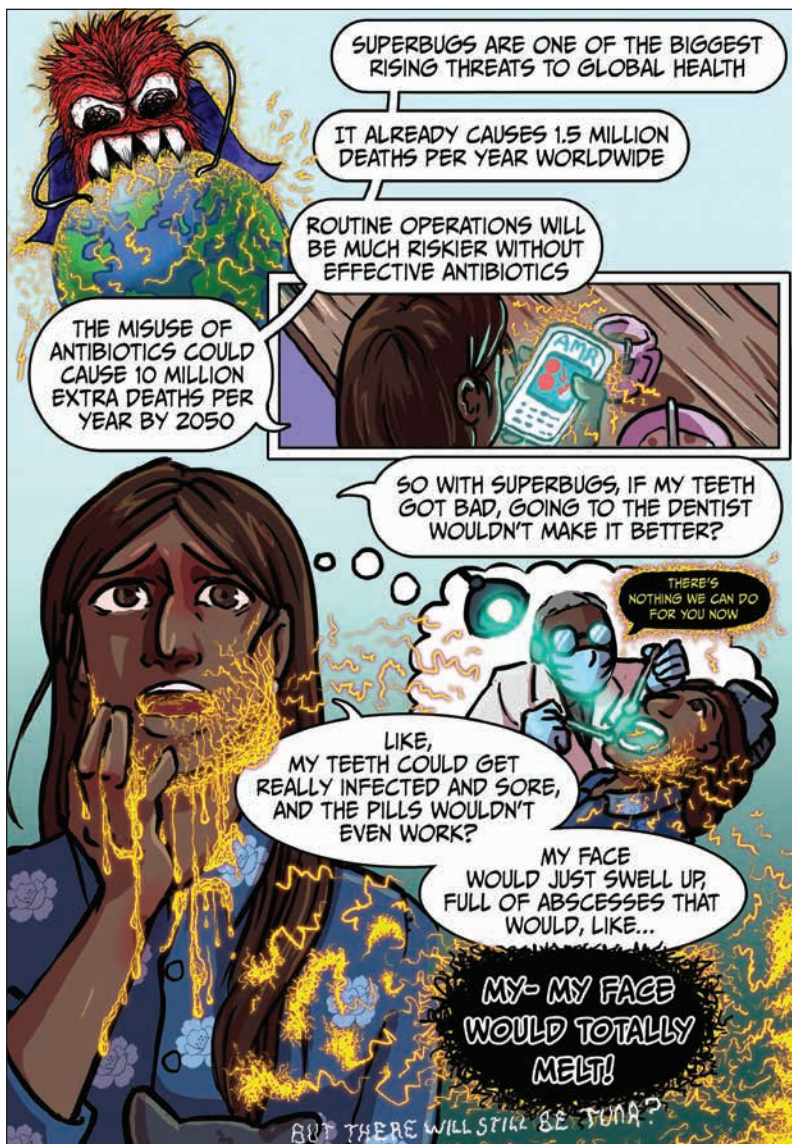
Eliza: I'm a compulsive doodler and during my PhD I used short incubation periods in the lab to draw cartoons on the whiteboard. This led to me making figures for my supervisor. After a while it seemed that this was where I was really useful in microbiological research and there was a need for someone like me to do this for other scientists.

Lizah: I have always loved to draw and make art, but it took me a long time to combine art with science. For me, art was always an escape from my busy academic life. But when one of my illustrations about handwashing went viral at the start of the pandemic, I saw the massive impact illustrations can have on people and that there is room for me in that industry.

What part of your job do you find most challenging?

Eliza: I get stage fright! The progress of an illustration isn't always linear; sometimes the magic bit happens right away and you can see where it is leading, and other times you have to keep trying things, just like in the lab. I'm always a bit nervous until I can see that I have solved the creative problem.

Lizah: Conceptualising the first idea to tell a story. Once there is an idea, the drawing is easy, but going from a blank page to 'something' is always the hardest part for me.



The sorcerer of the invisible, the friend of microbes: the microbiologist in Benin, a road made of passion and sacrifices

Victorien Dougnon

I often tell my collaborators, students and colleagues that I am a sorcerer. I have hammered it in so much that many now call me this systematically. Yes, I have been conquered by the world of microbiology. In my country, Benin, there are specialists of the invisible who are called sorcerers. Public opinion sometimes attributes supernatural powers to them, and they have a rather negative connotation. But that's not why I like to be called a sorcerer. It is a microbiologist's ability to question living beings invisible to the naked eye that pushed me to make this comparison.

I am a pure product of polytechnics. I did all my studies at the Ecole Polytechnique d'Abomey-Calavi (EPAC), Benin, where I had teachers who gave me a very solid foundation in biology. Of all the subjects taught from the first to the fifth year of my training, I had a particular interest in microbiology, a science that is easily combined with many other disciplines in biology, such as immunology, biochemistry, haematology, etc. This passion was born during my first steps into university and was maintained by my personal culture. I wished to mark my existence by my devotion to science and to advancing knowledge in this discipline.

Convinced that microbiology can indeed be a foundation for development in this country, I have always been able to transmit my passion for research to my students and collaborators. Being a lecturer in Benin means first of all being willing to sacrifice one's personal life for the benefit of students' training. From the beginning of my career, I have had to face many challenges but, with a dedicated team and

visionary colleagues, I have been able to provide appropriate answers.

Challenge one: the issue of training

As a lecturer in the Department of Human Biology Engineering, I can say that our training attracts many students. However, we do not have what it takes to cope with the challenges of time. Initially, our school was provided with funding from Canada for the building and initial equipment for the laboratory 40 years ago. Over time, the number of students increased tenfold. I currently teach microbiology to nearly 100 students in the third year of their bachelor's degrees. This is a very high number as regional guidelines suggest a maximum of 25 students per classroom. The laboratory has not changed, and some of the equipment is older than me, for example my incubator in the laboratory is now almost 40 years old. Huge sacrifices must therefore be made by forming pedagogical groups of students and, therefore, repeating the manipulations as many times as possible. To respond to this paradigm, with a group of teachers, we took advantage of the COVID-19 crisis to encourage e-learning. So, to promote microbiology among undergraduate students, I produced an e-learning tool available online (elearning-uac.bj) and an app for Android phones and tablets.

In order to give young students the chance to acquire Master's level qualifications comparable to what is done in Northern countries, I have initiated the establishment of an MSc program in Molecular and Medical Microbiology

(urmapha-epacuac.bj/index.php/master-en-microbiologie-moleculaire-et-medicale). This program was set up to prepare some well-trained specialists in microbiology. Those specialists were very useful in Benin during the Lassa fever pandemic and the recent COVID-19 outbreak. We offer these students a specialised theoretical and practical program on specific biological concepts.

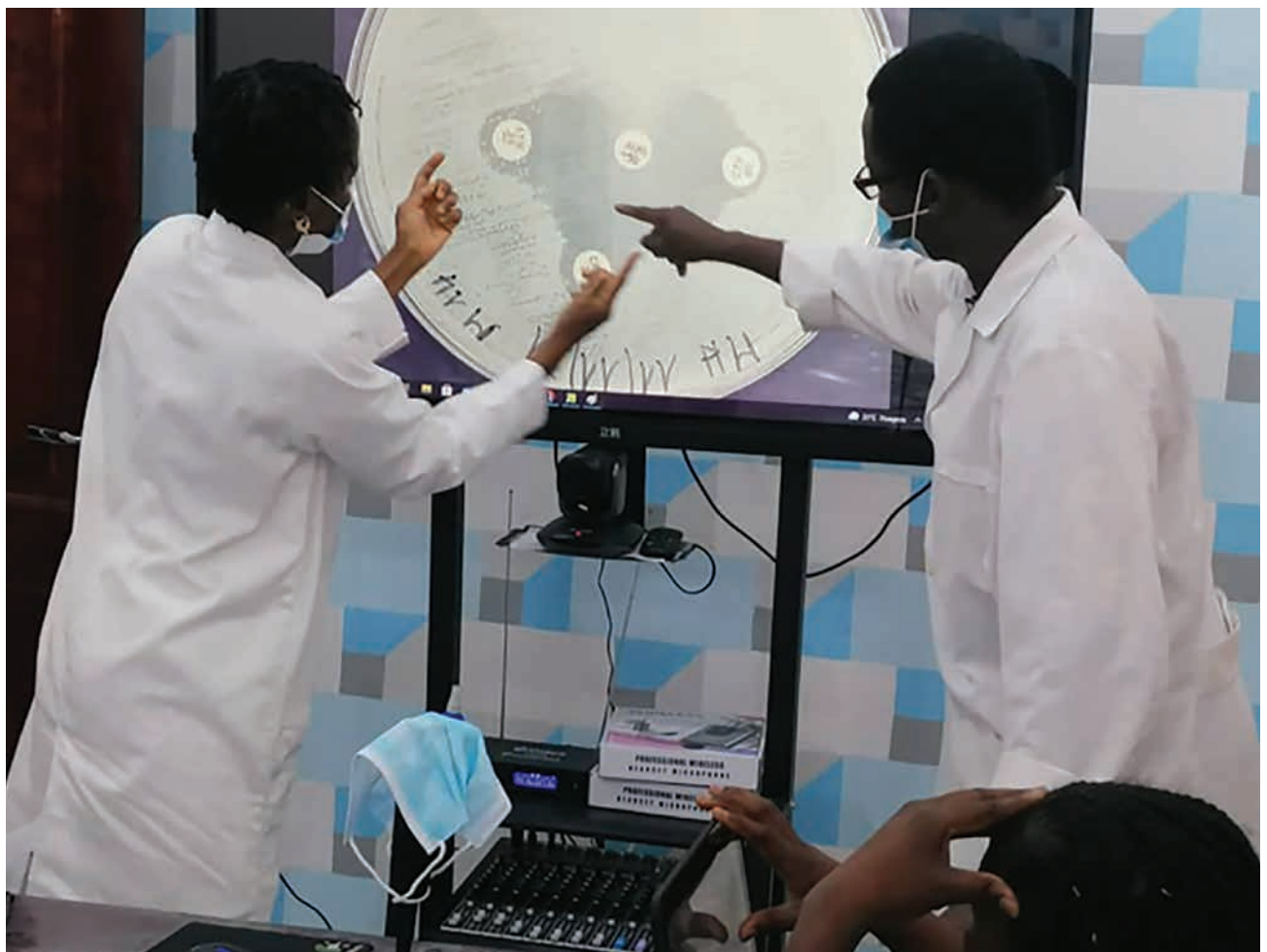
Challenge two: infrastructure and equipment

Living my passion as a microbiologist required me to be surrounded by hard-working and dynamic colleagues. To date, we have been able to meet the challenge of being a developing country. Through collective efforts, we have set up a large

multidisciplinary research laboratory (youtu.be/YceZr5UgXxE) with state-of-the-art equipment and technology to address development issues, such as health and environmental problems in Africa and worldwide, in the biological sectors.

Each day comes with its own set of realities, but I remain convinced that I must do better than the day before to offer new opportunities to the thousands of students we train: to live from research. This implies being a living example of self-sacrifice, work well done, rigour, scientific culture and fulfilment as a researcher. This is my vision, my struggle and one of my primary reasons for living.

Overall, my research contributes directly to the achievement of the United Nations' Sustainable Development



Victorien Dougnon

Goal 3 (Access to health), 4 (Access to quality education) and 6 (Access to safe water and sanitation). As a Young Affiliate of the World Academy of Sciences (TWAS) in 2016, I have collaborated with 150 researchers from over 80 research institutes around the world to date. I am the current Head of the Research Unit in Applied Microbiology and Pharmacology of Natural Substances, Applied Biology Research Laboratory, Polytechnic School of Abomey-Calavi, University of Abomey-Calavi.

Each year, more than 150 young researchers are impacted by the activities of this laboratory. My academic career has been regularly enriched by participating in international workshops and symposia, visiting partner laboratories abroad as well as completing training funded by various international scientific institutions. From 2015 to date, I have won 15 competitive research projects as a principal investigator or local coordinator, one as a collaborator and more than 35 travel awards. My research outputs include the work of six PhD students and 25 master's students, 138 peer-reviewed journal articles including 40 in A-ranked journals, and 75 conference abstracts. One of my research projects has led to the production of 03 phytomedicines called SALM-MTA against salmonellosis. In 2020, with my team, I produced

a biopesticide against mosquito larvae based on *Bacillus thuringiensis*. These innovations have allowed me to be invited by many television stations in Benin and have received special recognition from the Rector of the University of Abomey-Calavi. One of my multiple collaborations led to the discovery and sequencing of lytic bacteriophages infecting *Acinetobacter baumannii* from Beninese wastewaters.

In light of my ongoing contributions to research, capacity building and sustainable solutions, the American Society for Microbiology (ASM) selected me as a Young Science Ambassador for 3 years from 2016 before promoting me to National Ambassador in 2019. After a global selection, I was also recruited as a member of the prestigious Global Young Academy (GYA) in 2019 and then as a Champion of the Microbiology Society. I have led and contributed to the training of many science researchers. During the COVID crisis in Benin, my team contributed to the fight against the escalating price of hydroalcoholic products by producing them locally at lower prices. I advocate for causes of interest in Africa, as was the case with the COVID-19 memorandum and the fight against predatory journals in developing countries where I play a key role.



Victorien Dougnon



Victorien Dougnon

About the author



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researchgate.net/profile/Victorien_Dougnon

Through his work, Victorien is involved in the fight against antimicrobial resistance in Africa. As a scientist, his interests are linked to molecular microbiology, hygiene and public health, with a particular passion for the use of medicinal plants against infectious diseases.

What advice would you give to someone entering this field?

I would advise them to be passionate. Passion is the key word to go through all the difficulties. This world of microbes is marvellous if you are ready for it. You also need to have a great sense of rigour and commitment. Once you get that, the world is yours.

Why does microbiology matter?

Our world as humans is in constant relationship with micro-organisms. How can we live with them if we don't rely on strong science to support? That is why microbiology matters. Because we need to save lives. Because we need to promote biotechnology using the benefits of microbes. Because microbes are our friends and the small part that is harmful is well known by this science.

Annual Conference 2022

Monday 4 April–Thursday 7 April 2022

ICC Belfast

In April, the Society welcomed over 1,400 delegates to its flagship Annual Conference, which saw a return to its in-person annual meeting format following a two-year hiatus.

The Society was delighted to return to Belfast and its International Convention Centre, which hosted a global speaker line-up of experts within their field, presenting over four science-packed days.

The event included:

- 28 scientific sessions
- talks from 150 invited speakers
- around 270 offered talks
- around 550 posters
- three sessions dedicated to Microbiology Society professional development:
 1. Microbiology careers fair
 2. Teaching microbiology in higher education symposium
 3. Publishing fundamentals
- two Hot Topics:
 - **Climate change: integrating the influence and trajectories of microbes past, present and future** – Professor Alexandra Worden (GEOMAR, Germany)

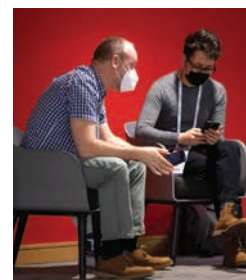
- **Lessons learned from covid-19: are we ready for the next pandemic?** – Professor Wendy Barclay (Imperial College London, UK); Emma Thomson (University of Glasgow, UK); Gavin Yamey (Duke University, USA)

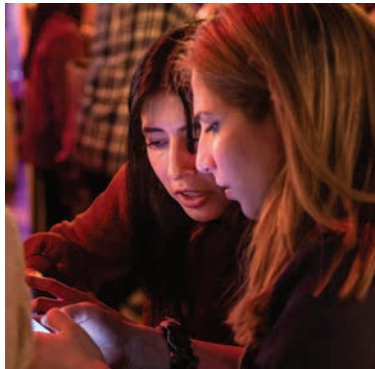
- five Prize Lectures

Following the popularity of the Society's virtual events over the past two years, Conference also integrated some of the best online elements from this time. This included an e-poster directory, an event app and a virtual event platform for legacy content.

Don't forget! If you presented work at our Annual Conference 2022, submit your article to one of our many Journals to continue to support the work of the Society and the microbiological community. Visit our journal platform to find out more: microbiologyresearch.org/submit-an-article.

Visit our YouTube Channel (youtube.com/MicrobiologySocietyOrg1945) to see some of the material we captured from this year's event.





All photos: Ian Atherton



ICC Birmingham

Annual Conference 2023

Monday 17 April–Thursday 20 April 2023

ICC Birmingham

Preparation is now well underway for Annual Conference 2023 which will take place at the ICC Birmingham.

The programme is currently in production with our Scientific Conference Panel and Divisions who are working across the broad range of microbiology topics and its various disciplines to deliver an exciting and cutting-edge programme. In addition to the scientific programme, the Society will be hosting a series of Professional Development sessions for all delegates, along with posters and social activities.

Destination Birmingham

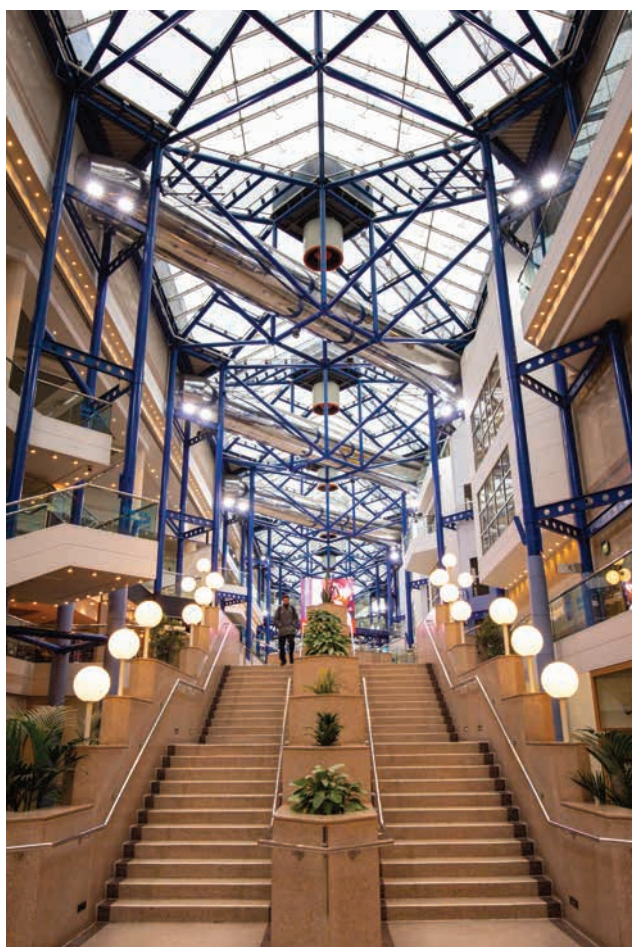
Birmingham is a city with forward-thinking architecture and expansive waterways, and is lined with history, culture and lifestyle. If you're planning on extending your stay after Conference, the city has world-class museums and galleries to explore and rewarding culture and heritage to discover.

Go to the 'Visit Birmingham' website (visitbirmingham.com) for further information about this city.

Programme

As always, Annual Conference is designed to cover the breadth of microbiology research, and its comprehensive scientific programme has sessions taking place over four days in a range of formats.

Sign up to our newsletter to ensure you are receiving regular updates about Conference and other Society news and visit www.microbiologysociety.org/events for further information.



Annual Conference 2023

17–20 April, ICC Birmingham, UK

Save the date

#Microbio23



Focused Meetings 2022

The Society organises a varied programme of Focused Meetings each year, with the aim to bring together those with shared scientific and clinical interests to shape the future of microbiology, strengthen membership networks and enable knowledge exchange. Following disruption to our events schedule in recent years, we are planning to deliver our most ambitious and varied meetings programme in 2022, featuring a variety of postponed meetings alongside some newly planned meetings covering the depth and breadth of microbiology.

Further information about any of the Society's Focused Meetings can be found online at microbiologysociety.org/events.

Microbial Cycling of Volatile Organic Compounds

25–26 May 2022

John Innes Centre, Norwich, UK

The first Focused Meeting of the year will bring together those working within the field of Biogenic Volatile Organic Compounds (BVOCs). The meeting will address recent advances in the field of BVOC microbiology, such as the discovery of new degradation pathways, the role of BVOCs in inter- and intra-species signalling, new techniques to explore the volatile metabolome and synthetic biology approaches to create novel BVOCs.



Jung/iStock

Europic 2022

5–9 June 2022

Harrogate Majestic Hotel & Spa, Harrogate, UK

Europic is the premier world virology conference that focuses on studies of picornaviruses, a family of important human and animal pathogens including enteroviruses (e.g. poliovirus, rhinoviruses, EV-A71, EV-D68), hepatitis A virus and foot-and-mouth disease virus, as well as many other viruses whose number is growing by the day with new discoveries.

The Microbiology Society is delighted to be hosting the meeting in 2022 to bring together the international community to hear about the latest advancements in the field of picornaviruses and enjoy numerous networking opportunities to help strengthen relationships within the scientific community.

Cell–Cell Communication in Bacteria – Fundamental and Applied Aspects

28–30 June 2022

University of Cambridge, Cambridge, UK

Communication between single species and within polymicrobial communities has profound impacts on host–microbial interactions in the context of health and disease, and its understanding offers diverse translational opportunities in medicine, agricultural and industrial contexts.

The Cell–Cell Communication in Bacteria (CCCB) Focused Meeting will bring together a multidisciplinary audience of microbiologists, structural, systems, evolutionary and synthetic biologists, mathematicians, chemists, biochemists and ecologists and will provide a vital forum for the dissemination and exchange of new information and to foster the next generation of scientists working in this area.

What's new in *Cryptosporidium*?

4–5 July 2022

Swansea University, Swansea, UK

Cryptosporidium is the most common parasitic cause of gastroenteritis in the UK and one of the most important contributors to the burden of childhood diarrhoea morbidity and mortality globally.

This one-and-a-half-day meeting will provide an opportunity to those working in clinical, industrial, veterinary and agricultural settings to hear about advances in the field, share good practices and establish collaborations with others across science, industry, public and environmental health, and clinical and veterinary practice.

British Yeast Group 2022: From Genomes to Cells

7–9 September 2022

University College London, London, UK

Yeasts are very versatile, model unicellular eukaryotes that have been extensively used for over a century to explore fundamental aspects of living systems. Annual gatherings of the British yeast community have taken place since the 1980s, and the Microbiology Society is pleased to be incorporating the BYG meeting in its Focused Meeting Programme for the fifth time next year. The programme will feature attractive, assorted talks from invited speakers and will provide plenty of opportunities for early career researchers to present their research through posters and offered oral presentations. The meeting will include a varied social agenda providing opportunities to make new connections and strengthen the yeast community in Britain and beyond.

You can view the associated collection of peer-reviewed content on yeast from across the Society's publishing platform at microbiologyresearch.org/content/yeast.

Genomes of Microbiomes

15–16 September 2022

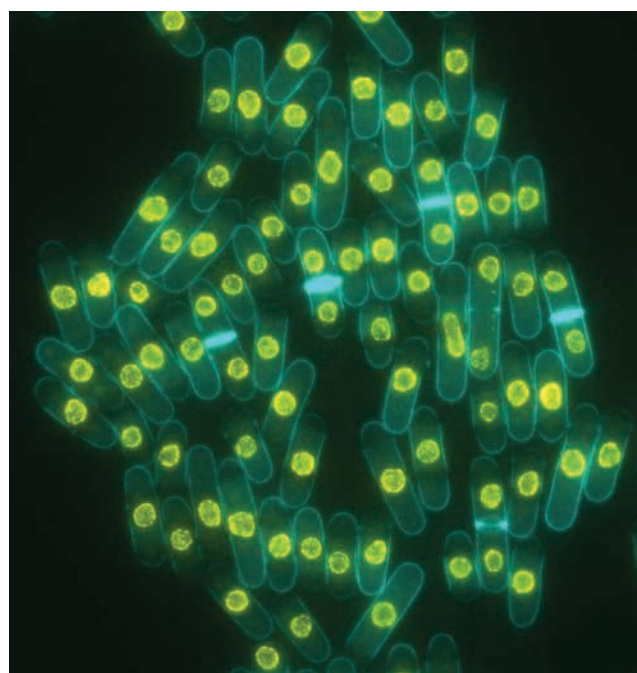
Edgbaston Park Hotel and Conference Centre,
Birmingham, UK

The field of microbial genomics is progressing rapidly and has attracted growing interest within the research community of microbiologists. This meeting will bring together an audience of researchers who are keen to hear about how advances in sequencing technologies and computational methods can be best exploited to understand the microbial world.

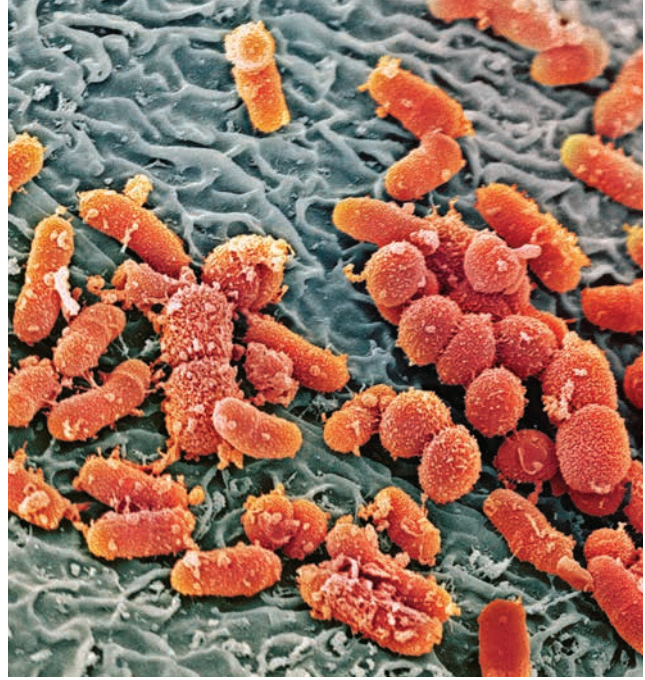
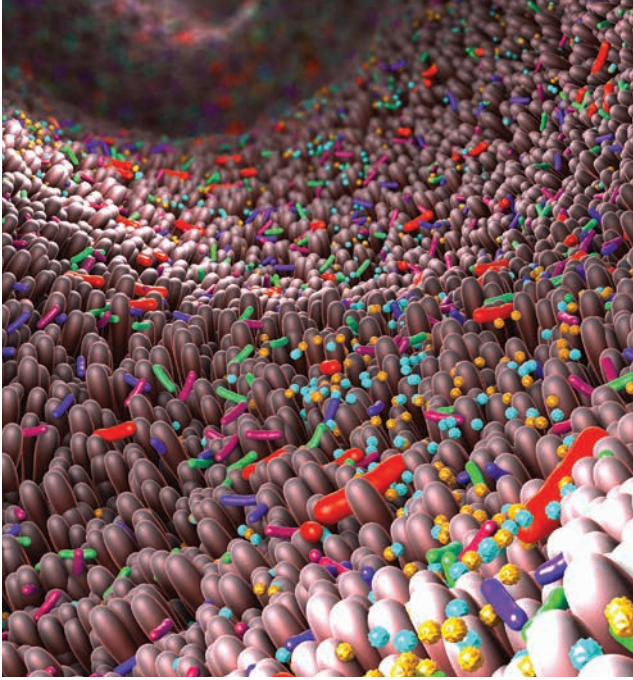
One recent highlight in microbial genomics has been the redefinition of our understanding of evolution and microbial diversity using metagenome-assembled genomes (MAGs), as well as the wider issues around obtaining genomes from microbial communities.

This meeting will provide a forum for the discussion of the impact of MAGs, including how they should be incorporated into public databases, metagenomics advances in general, and the contributions technologies are making toward more readily achieving complete microbial genome sequence assemblies.

You can view the associated collection of peer-reviewed content on the microbiome from across the Society's publishing platform at microbiologyresearch.org/content/microbiome.



Scott Curran



Gut Microbiome and Mucosa-Associated Infectious Disease: Mining for Antimicrobials and Postbiotics with Therapeutic Potential

27–28 October 2022
Trinity College Dublin, Ireland

With the emergence of antibiotic resistance and the decreasing effectiveness of antibiotics there is growing interest in the potential of mining the gut microbiome for new antimicrobials.

This Focused Meeting will provide an insight into the current state of research on the exploration of the interactions between the gut microbiota, pathogens and the mucosal immune system in the search for new alternatives for the treatment of infectious disease.

Protein Secretion at the Host–Pathogen Interface

3–4 November 2022
Queen's University Belfast, Belfast, UK

Bacterial infections remain one of the top causes of human suffering and death globally and have a huge economic impact on agriculture and animal production. The ability of nearly all important bacterial pathogens to cause disease depends on secretion systems, which deliver virulence factors to the surface or directly into host cells, where they modulate host processes to the benefit of the bacteria.

There have been plenty of new scientific discoveries pushing our understanding of the molecular basis of host–pathogen interactions to new levels, and this meeting has been

organised to foster the exchange of information, networking and new collaborations across the research community.

Understanding and Predicting Microbial Evolutionary Dynamics

22–23 November 2022
Hyatt Regency Manchester, Manchester, UK

This meeting will bring together leading researchers working on microbial evolution from across varied disciplines, including infectious diseases, genomics, environmental microbiology, biotechnology and mathematical modelling. This will provide a unique opportunity to allow this multidisciplinary community to identify the common themes and shared approaches for understanding and predicting microbial evolutionary dynamics across these diverse systems and applications.

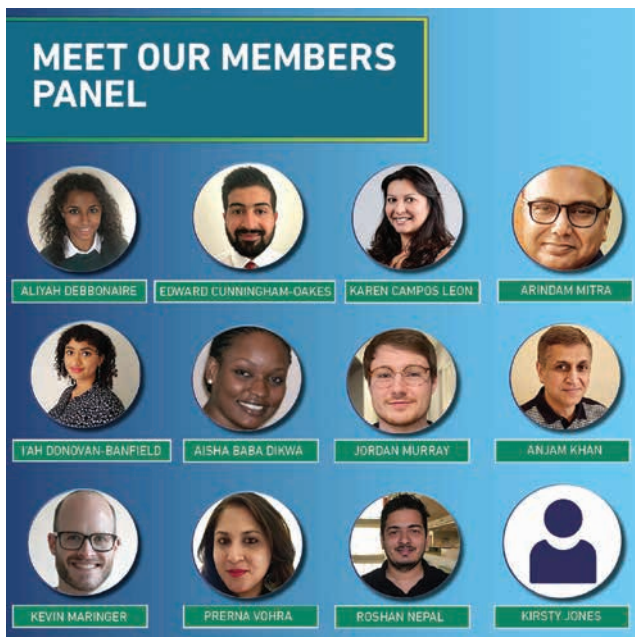
Call for 2023 Focused Meeting proposals

Have you got an idea for a Focused Meeting?

All members of the Society are welcome to submit a Focused Meeting proposal covering any area of microbiology. If approved for inclusion in the Society's events programme, the meeting will be delivered in collaboration with the organising committee, who will lead on the scientific aspects, and the Society's Conference and Events team, who will provide full secretarial support and manage all logistical and operational aspects.

We're currently seeking proposals for the Society's 2023 Focused Meetings programme. Find out more at microbiologysociety.org/events or email us at conferences@microbiologysociety.org if you wish to discuss your idea for a meeting proposal. The deadline for submissions is **9 June 2022**.

Meet our Members Panel



In the November 2021 issue of *Microbiology Today*, we shared the ways in which the gender balance across Society activities and governance has improved over the past few years, and how the Society has taken steps to look beyond gender to ensure we are welcoming to all interested in microbiology, regardless of their background.

In aid of the latter, we announced a call for members to join our new Members Panel, a way to bring the voice of underrepresented groups to the fore throughout all levels of decision making at the Society.

I am honoured to be working with such talented individuals, all of whom are equally qualified to be chairing this panel. The sheer diversity of this panel, the likes of which has not been seen elsewhere in the Society, is beyond exciting! As a Chair, I aim to work with the panel to provide transparent, actionable objectives for improving EDI across the Society and beyond. Through this, I hope to show how committed we are to bringing about change at the intersection between career path and personal background that many of us face daily.

Dr Edward Cunningham-Oakes
Co-Chair of Members Panel

The first Members Panel was announced in January this year and includes members from across the world, from different career stages and with different interests across the spectrum of microbiology.

I'm really excited about the formation of the Members Panel, as it now gives members from underrepresented groups a more direct and visible way to feed into Society governance and activities. My personal hope for my term as co-Chair is that we can encourage more open discussions on how the Society can engage, represent and support LGBTQ+ members and those who identify with other invisible characteristics like lower socioeconomic background and first-in-family to university, because these are discussions that are not yet well developed within academia and the microbiology field.

Dr Kevin Maringer
Co-Chair of Members Panel

For the next three years, the Panel will be co-Chaired by Dr Kevin Maringer, Group Leader at The Pirbright Institute, and Dr Edward Cunningham-Oakes, Postdoctoral Research Associate at the University of Liverpool. The co-Chairs will work with the General Secretary's Group to ensure that equality, diversity and inclusion matters continue to be appropriately considered at the highest level of Society governance.

If you would like to share your experiences, suggestions and questions with Members Panel Representatives, please contact them through the Members Directory or via members@microbiologysociety.org and we will put you in touch. To follow along on social media, please check [#MicrobioMembersPanel](https://twitter.com/MicrobioMembersPanel) – where the Panel will promote opportunities to get involved with activities and initiatives it is organising.

Publishing for the Community: Transition milestones – our Open Access journey

Our focus at the Society has always been publishing for the community – where the income generated from our journals is returned to support activities that benefit all.

In its 75th year, we prepare for the Society's founding journal, *Microbiology*, to become fully Open Access (OA) in 2023. A fully Open Access *Microbiology* benefits our membership, all microbiologists and anyone interested in microbiology, and ensures that our authors are completely funder compliant. At this turning point in our publishing history, we look back on two years of unprecedented progress and look forward to charting the milestones as our publishing programme becomes predominantly OA, shifting from our reliance on subscriptions.

OA growth

In 2021, 43% of all articles published across the portfolio were immediately made OA, either through payment of an Article Processing Charge (APC) or funded by a Publish and Read (P&R) transformative agreement. As shown in the figure below, we have seen significant year-on-year growth (38% more in 2021 than 2020) in the proportion of OA publishing in our journals, putting us on track to exceed an important benchmark – to publish more OA articles than paywalled articles in 2022. As we succeed in bringing more institutions to our Publish and Read programme, OA growth will be further

fuelled by institutional financial support, relieving authors of the need to fund their publication costs.

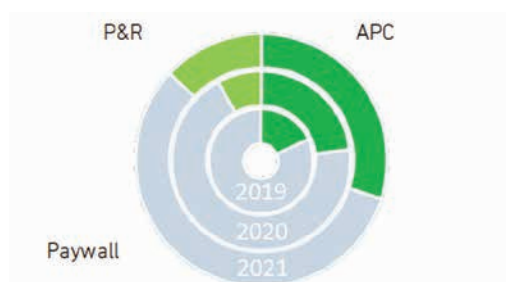
Looking forward, our ambition over the coming years will be to ensure publishing for the community – where the income generated from our journals is returned to support activities that benefit our community – can be delivered transparently and sustainably. Our data suggest that the number of OA articles published will overtake those coming from subscriptions. In addition to this, the income generated from OA models is forecasted to exceed subscriptions over the next renewal cycle, when *Microbiology* flips fully to OA.

Over the mid-term of the next three–five years, we will be working to increase article output in all titles across the portfolio. The strongest driver of that growth will be in OA publishing, providing a solid base for a sustainable OA future.

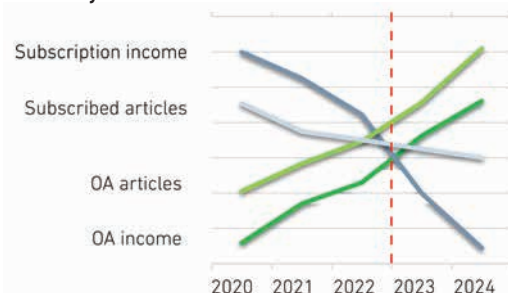
The success of the Society's Publish and Read model

The expansion of Publish and Read since 2020 has been a driving force of OA growth. In 2022, the Society has for a second year doubled the number of institutions benefiting from this model, achieving two of our key objectives.

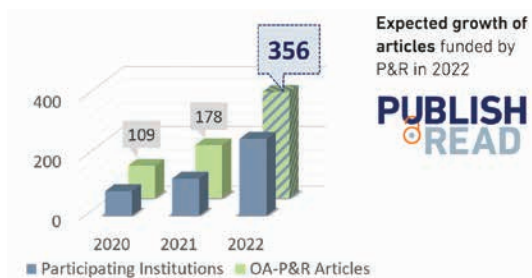
The proportion of OA articles in all journals of the Society has reached 43% in 3 years



With OA articles projected to surpass subscribed articles and OA income to exceed subscriptions, **2022 is set to be a transition year**



Publish & Read enables more scholars in more institutions to publish their work **OA**



Firstly, an ever-increasing number of authors benefit from fee-free OA publishing. Secondly, it drives OA publishing away from a currently APC-dominated model with the associated barriers it presents to authors who struggle to raise the funds themselves, a burden that disproportionately affects early career researchers.

As more institutions participate, we can predict a relative increase in the number of OA articles funded through this model and hope to celebrate the doubling of OA output again compared with 2021.

OA impact

In recent years, reviews published in scholarly communications literature on the citation advantages, and therefore on the visibility and impact, of OA have produced varied conclusions. From analysing our 2020 and 2021 article performance data, we found that OA articles on average receive twice as many citations and 3.7 times the level of usage (views and downloads) as paywalled articles. Whilst not comparable to some wider, more rigorous studies, the figures from our portfolio do indicate an enhanced probability of higher impact and enhanced visibility of articles published OA. We encourage all our authors who publish OA to take full advantage of the easy 'share' options offered by our publishing platform.

Showing a clear commitment to an open, transparent, and sustainable scholarly communication environment, the Microbiology Society is one of the pioneers in the transition of paywall-based scholarly publishing to open access.

Head of Information, Max Planck Digital Library, a Publish & Read partner since 2021

Usage and citations are key indicators of the impact of research articles: the probability of improving these metrics increased when published **OA** by the following factors



based on averages in all journals with citation data from Web of Science

Actions to achieving a fully Open future

Our priority as a Society publisher is for OA to become the predominant path to publishing research in a way that is both sustainable and serves the needs of microbiology researchers worldwide. As we continue to innovate by transforming our journals, our plans over the next few years are to:

- ✓ Improve inclusivity, benefitting more authors in more regions.
- 📈 Build more OA funding routes to spread publication costs.
- 🔄 See our first hybrid title, **Microbiology**, flip fully OA in 2023.
- 🔒 Innovate with new open science initiatives such as the open research platform **Access Microbiology**.

A key ingredient to our success has been collaborating with others who are similarly traversing the route to OA, including the not-for-profit publishers of the Society Publishers' Coalition. The self-publishing societies within the Coalition came together to create a scalable, cost-neutral model based on 'Unlimited OA' publishing, and this has created the best conditions for libraries and consortia groups to put their trust and budget into a collective endeavour.



We aim to align ourselves with the OA ambitions and agendas of research institutions worldwide, ensuring that inclusive, open and equitable practices persist for the next generation of microbiologists.

Jade Heyman

Journal Sales and Transformation Manager

j.heyman@microbiologysociety.org

Publishing for the community: share your research more widely – publish Open Access with us.

Publishing for the Community: A brief history of *Microbiology*

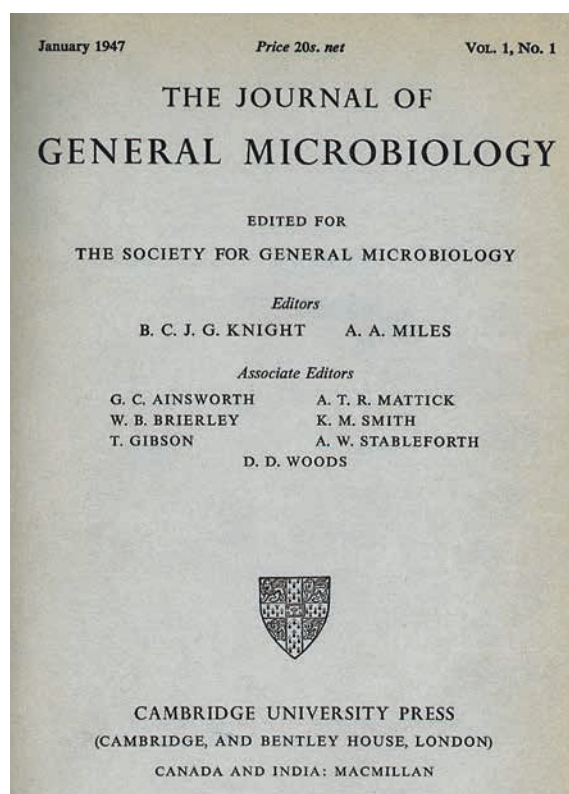
The Society for General Microbiology, as the Microbiology Society was called until 2015, held its inaugural meeting in February 1945. A new *Journal of General Microbiology* was fully envisaged at the time, but wartime conditions, including severe paper rationing, meant that it had to wait. In the event, the first Joint Editors were not formally appointed for another year, and the first issue appeared in January 1947.

Actually, it didn't. It appeared at the end of March 1947, after a series of delays at the publisher, Cambridge University Press (CUP), attributed among other things to the coal shortage and extreme weather conditions. Arguments about missed deadlines, and constant efforts to drive down the time between submission and publication of papers, were to be a constant theme in the history of the journal. The Society terminated its contract with CUP in 1980; then moved production back to CUP in 1993; but changed its mind again in 2002.

A second constant theme in the journal's history was concern about the disciplinary mix of the papers it published. The journal was intended to cover fundamental research in all branches of microbiology, in keeping with the commitment to 'general microbiology'. But the Society's origins in agricultural bacteriology faded slowly, and a decade after launch the editors were still complaining that too many papers were bacteriological. The categories have changed, of course, as the science has developed, but the journal still thinks in terms of the individual disciplines or research themes that constitute microbiology: the members of its Editorial Board are listed under those themes, and papers are grouped analogously.

The third long-running strand in the journal's history was, and is, money. At first, the journal was by far the Society's biggest item of expenditure. It fairly quickly turned into the Society's biggest source of income. Either way, it was central to all discussions about finance, and a constant worry. With no journal, the Society could not have grown to anything like its present status.

The *Journal of General Microbiology* was launched with a team of two Joint Editors (Gabe Knight and Ashley Miles) and seven Associate Editors (Geoffrey Ainsworth, William Brierley, Tom Gibson, Alexander Mattick, Kenneth Smith, Arthur Stableforth and Donald Woods). The only staff support was



Miles' secretary, who received an honorarium of £10 for each issue in recognition of the extra work it entailed for her. Arthur Standfast succeeded Ashley Miles in 1951, and he and Gabe Knight ran the journal until 1970, when they each retired and were made Honorary Members of the Society.

There were other structural changes around 1970: the introduction of the post of Editor-in-Chief; expansion of the Editorial Board and greater delegation of authority to it;



and, crucially, recruitment of dedicated staff. By 1986, the Society employed about 20 full time staff, over half of them on the various journals. The Editorial Board eventually grew to almost 100 in number, essentially to deal with the growth in papers being submitted. Between 1947 and January 2022, 720 individuals served on the Board in one or more voluntary roles, some over protracted periods of time.

Like all long-running entities, the *Journal of General Microbiology* went through periodic makeovers. During the 1980s there was growing concern about its old-fashioned image and its vulnerability to new, commercially aggressive journals. So its appearance was tweaked in 1990 with a new two-column format, a larger (A4) page size and a new cover design. But mere visual appearance was not enough: in 1994 it relaunched under a new name, *Microbiology*, in response to fears that the word 'General' implied it was handling only the bits of microbiology left over from the more specialised (i.e. interesting) competitor journals. The subject categories used to organise material in the journal were brought in line with current research trends, and rejection rates were increased to show it was serious about quality. It would be another 20 years before the Society itself followed suit and dropped the word 'General' from its name.

But the biggest change came with the advent of electronic publishing. The Society appointed a full-time Systems Manager in 1995 to support its response to the challenges of new technology, as, like all learned society publishers, it scrambled to come to terms with the apparent opportunities and threats. By 1998, virtually all papers were being submitted, and edited, on disc, and from May

2000 *Microbiology* was made available on HighWire as a full electronic publication, in parallel with continuing print publication. Within a year, *Microbiology Online* was receiving 30,000 hits per week. In 2001, it went open access with all papers being free to read 12 months after publication. By 2003, 75% of papers were being submitted electronically as PDFs; this became compulsory in January 2004. Print publication finally ceased altogether in December 2019.

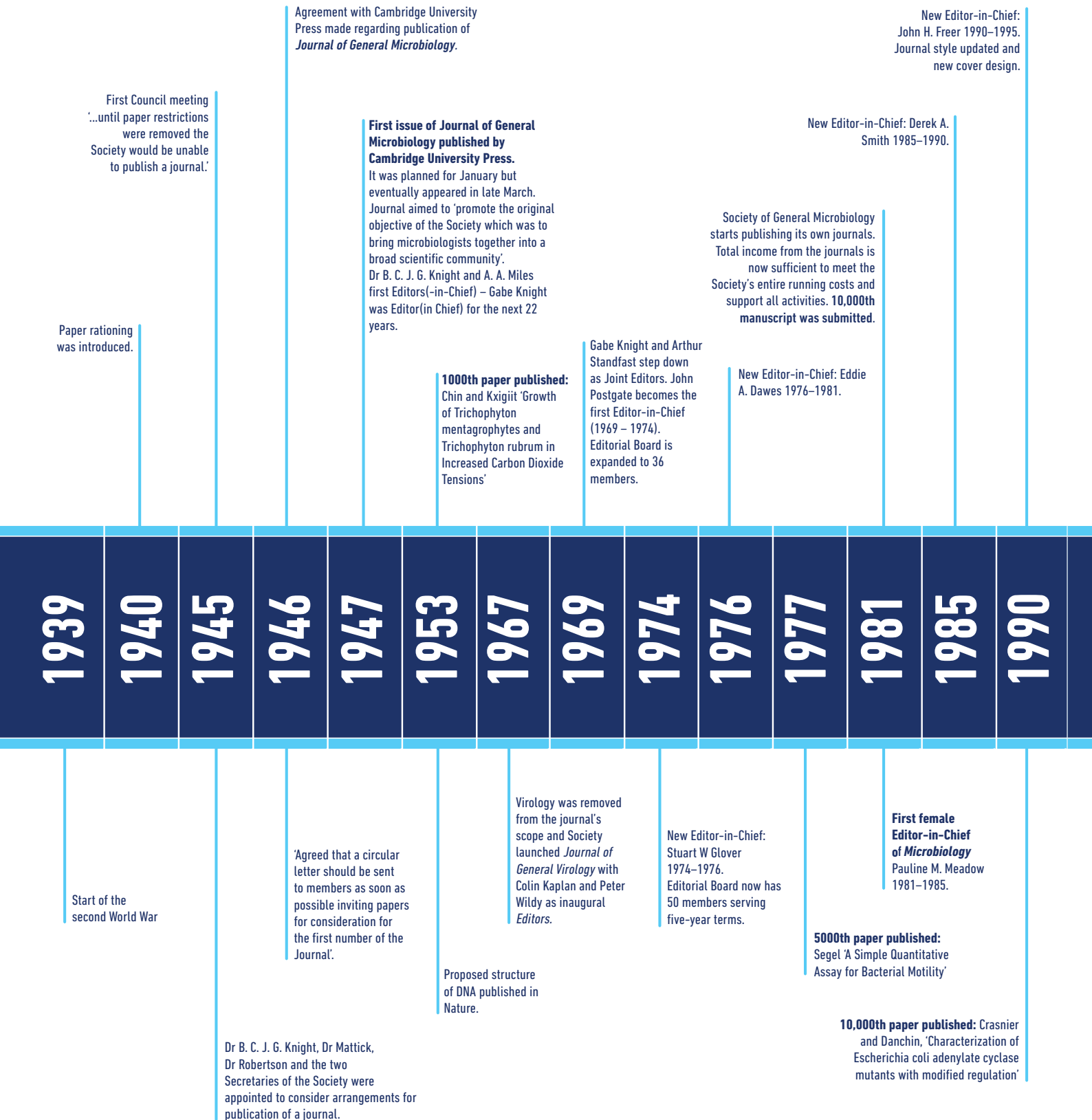
The journal saw itself as engaging with an international audience, and from time to time took steps to develop a more international persona. The Editorial Board started recruiting members from continental Europe in 1976, while the Society was developing relations with the Federation of European Microbiology Societies (FEMS). By 1994, when the journal was relaunched as *Microbiology*, 29% of Board members were based outside the UK; in the following five years, this figure was increased to 53% in a deliberate policy move. An office was opened in the USA to make it easier for researchers based there to submit papers.

These initiatives had an impact. In the later 1950s, about one-third of the papers published in the journal came from outside the UK, to the clear pleasure of the editors. In the 1970s and 1980s this figure rose to nearly half; in the 1980s it rose further to two-thirds, and to three-quarters in the 1990s. The early 2000s saw the non-UK proportion rise as high as 85%. This is in keeping with the Society's international presence: its current membership of over 6,000 is drawn from over 100 countries around the world.

Peter Collins

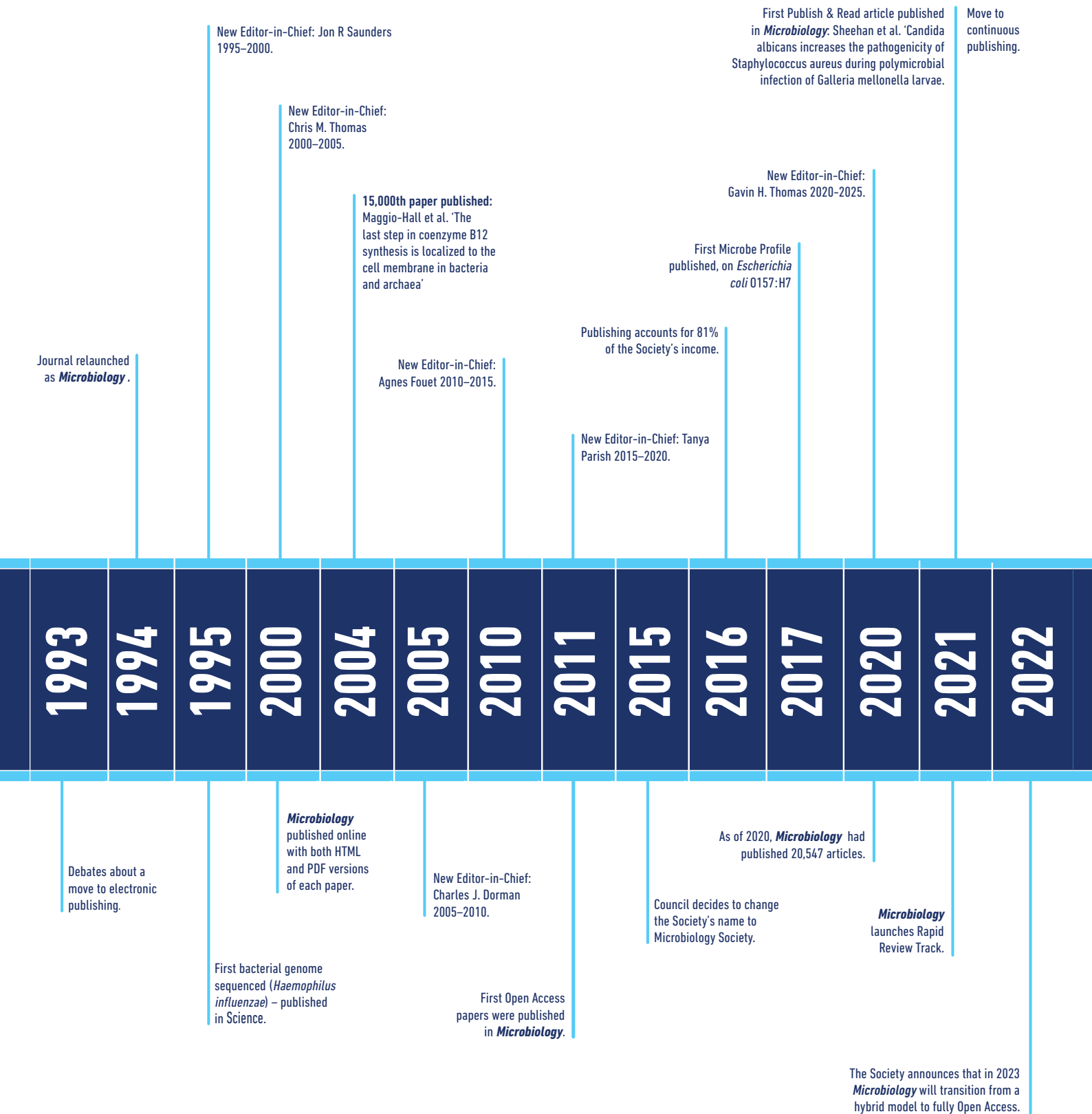
Emeritus Director, The Royal Society

A timeline of MICROBIOLOGY



Editors-in-Chief of *Microbiology*

- Bert Cyril James Gabriel (Gabe) Knight (1947–1969)
- Arnold Ashley Miles CBE FRS (1947–1951)
- Arthur Francis Bulmer Standfast (1952–1956)
- Sir John R. Postgate FRS (1969–1974)
- Stuart W Glover (1974–1976)
- Eddie A. Dawes (1976–1981)
- Pauline M. Meadow (1981–1985)
- Derek A. Smith (1985–1990)
- John H. Freer (1990–1995)
- Jon R Saunders (1995–2000)
- Chris M. Thomas (2000–2005)
- Charles J. Dorman (2005–2010)
- Agnes Fouet (2010–2015)
- Tanya Parish (2015–2020)
- Gavin H. Thomas (2020–2025)



Introducing MiSAC

Tansy Hammarton

What is MiSAC?

MiSAC is the Microbiology in Schools Advisory Committee. It was founded in 1969 (see *Microbiology Today*, November 2019, page 190) to promote the teaching of microbiology in schools and colleges and is a recognised authority on the safe use of micro-organisms in educational settings. MiSAC is sponsored by several learned societies (currently the Microbiology Society, the British Mycological Society and The Quekett Microscopical Club) and several educational organisations (SSERC, NCBE and CLEAPSS), and its membership comprises volunteers from each of the sponsor organisations (Dr Tansy Hammarton is the Microbiology Society's current representative on MiSAC), in addition to other experts.

What does MiSAC do?

MiSAC provides a wide range of resources, activities and advice to promote and enhance microbiology teaching and the safe use of micro-organisms in schools and colleges. Resources developed by MiSAC can be downloaded from its website ([misac.org.uk](https://www.misac.org.uk)). These range from briefing notes on particular aspects of microbiology to resources for laboratory

practicals (including the *Practical Microbiology for Secondary Schools* booklet developed by MiSAC and funded by the Microbiology Society) to documents providing information and advice on safety and good laboratory practice. MiSAC also provides links to other related organisations and resources. In 2019, to recognise MiSAC's 50th anniversary, a collection of more than 30 Anniversary Articles ([misac.org.uk/anniversary-articles.html](https://www.misac.org.uk/anniversary-articles.html)), written by experts and discussing a wide range of microbes and their activities, was published online. The collection was edited by Dr Margaret Whalley, a member of the British Mycological Society, and Microbiology Society member Dr Rachel Exley, then the Society's representative on MiSAC. Some articles have subsequently been translated into Swedish to satisfy international interest!

Perhaps the most popular activity MiSAC organises is an annual competition ([misac.org.uk/competition.html](https://www.misac.org.uk/competition.html)), aimed at secondary school pupils, that is closely linked to the National Curriculum and attracts up to 2,000 student entries a year. Similar competitions have also been organised through MiSAC in Thailand and China. Pupils in two age categories (KS3 and KS4, or S1/2 and S3/4 in Scotland) are encouraged



Ridofranzi/Stock

to produce informative and visually stimulating posters or web pages to inform teenagers about topical areas of microbiology. In recent years, these have included how microbes help in farming, how vaccines work and are used to control infectious diseases in children, and fungi and climate change. All entrants receive a certificate, and winning students and their schools receive a share of the £1000 prize money. The theme of the 2022 competition is 'Microbes made my lunch', with students being encouraged to produce a poster aimed at teenagers on a catering or food microbiology college course.

MiSAC also has an email helpline for teachers and technicians in schools and colleges, and answers queries and provides advice on an *ad hoc* basis. Responses to helpline queries are published on the MiSAC website as an additional resource.

Members of MiSAC also give talks, either to individual organisations on request or at conferences, and contribute to microbiology training courses and workshops. Over the years, MiSAC members have advised the government and organisations such as the Association for Science Education on the safe use of micro-organisms in schools, and have interacted with exam boards, science suppliers, publishers and industry.

Finally, MiSAC's reach has been expanding internationally, particularly to countries in South-east Asia. For the past decade, MiSAC has collaborated, through Dr Margaret Whalley, with the Thai Institute for the Promotion of Science and Technology Teaching (IPST) and, more recently, with UNESCO's South-east Asian Ministers of Education Organisation (SEAMEO) STEM-ED, to develop microbiology education programmes for secondary schools. The current programme is highly topical, aiming to raise awareness of the importance of vaccination by running online microbiology workshops for teachers from SEAMEO's 11 partner countries. Teachers are then able to support their students to produce videos on the role of vaccines in disease control for a schools' competition.

How can MiSAC help me?

Practical lessons really enhance the curriculum and bring science to life for school and college students, but taking microbes into schools or working with them in classrooms potentially introduces health and safety risks, and legislation for schools is very different from legislation for research labs. The MiSAC website provides many useful documents in this regard ([misac.org.uk/infoleaflets.html](https://www.misac.org.uk/infoleaflets.html)). Only certain micro-organisms (which are all ACDP Hazard Group 1

organisms) are permitted in schools, so consult the Suitable and unsuitable micro-organisms list ([misac.org.uk/healthandsafety.html](https://www.misac.org.uk/healthandsafety.html)) if planning any microbial practical work. Further, work with micro-organisms in schools falls under three levels depending on several factors, including the species used, the techniques being carried out and the age/experience of the pupils. These levels (1–3) are unrelated to the ACDP Hazard Groups or containment levels under which microbes are handled in research labs. Work that falls under Levels 2 or 3 requires technicians to be trained to Level 3 to prepare the resources required and will require the use of more specialised equipment (e.g. an autoclave) and disinfection procedures, so be sure to check what expertise and facilities are available in the school before you go. MiSAC has also produced a guide to risk assessment for work with micro-organisms in school, and a variety of tried and tested practical activities are available, which will help you plan your activities.

Other resources

If you are thinking about working with schools and colleges, you may also like to consider becoming a STEM Ambassador ([stem.org.uk/stem-ambassadors](https://www.stem.org.uk/stem-ambassadors)). This scheme provides generic training for working within educational settings, including safeguarding and health and safety training, provides insurance for Ambassadors carrying out STEM activities in schools, and can help link you with schools wanting assistance. There is also a huge range of resources freely available on their website. Finally, you may also wish to delve into the offerings of the online open access journal *Frontiers for Young Minds* ([kids.frontiersin.org](https://www.kids.frontiersin.org)). Articles are written by scientists for kids and are reviewed by kids aided by a science mentor to ensure they are suitable for the target age group – there is a vast array of articles on different microbes and the immune system to access.

Further reading

Microbiology Society. Practical microbiology for secondary schools; 2016. <https://microbiologysociety.org/publication/education-outreach-resources/practical-microbiology-for-secondary-schools.html>.



Tansy Hammarton

Microbiology Society representative in MiSAC

Spotlight on Grants: Education and Outreach Grant

The Education and Outreach Grant is available to support relevant science teaching or promotion initiatives, or developments likely to lead to an improvement in the teaching of any aspect of microbiology.

Earlier this year, Dr Martin Khechara, University of Wolverhampton, UK, organised and ran his engagement project 'Infection Infection: Time for Detection' in the Mander Centre Community Hub, Wolverhampton.

The aim of the project was to provide free and accessible learning experiences to the local community in order to raise aspirations around STEM, and to provide an opportunity to relate microbiology to the real world.

During the event, Martin and the STEM response team specifically encouraged conversations about microbes, microbiology and their application to society. Through this, they were able to explore how the NHS is able to identify and diagnose infectious diseases, with specific links to the COVID-19 crisis. In turn, this helped to reduce some of the misinformation or concerns held within the local community.

Martin said that *"the real highlight of the project was being able to bring microbiology to the centre of our community and*

show how the care pathway for microbiology works to keep people safe. The whole project helped so much to develop my communication skills with the public and I would encourage members to apply as it gives such a valuable opportunity to be able to meet the people our work actually impacts on."

Since the project's completion, Martin and his team have been able to *"refine and resource what is a fantastic, hands-on experience to promote microbiology. We have now created a mobile version of 'Infection, Infection: Time for Detection' and plan to take it to schools, events and science festivals all over the country over the next two years."*

Applications for the Education and Outreach Grant open twice a year, in January and June, with deadlines in April and October, respectively. To find out more about the wide range of grants available to support Microbiology Society members, visit the grants area of our website (microbiologysociety.org/grants).



As the Gram stain is such an important part of diagnostic microbiology, everyone attending got the opportunity to look at and interpret stained samples of different bacterial organisms. STEM Response Team



A wide variety of resources were developed specially to support the learning journey through the interactive workshop and give those attending something to take away. STEM Response Team

Get involved: Microbiology Society Champions Scheme

If you are a member of the Society looking to engage with other members and get more involved in Society activities, why not volunteer to join our Champions Scheme? The scheme is a great way to aid your personal and professional development and stand out from the crowd.



You don't need any special skills to become a Champion, just a passion for your subject matter and an enthusiasm to communicate it widely. When you become a Champion you'll have access to a support network of other Champions to help to make your ideas a reality.

Champions help to raise awareness in their local area of the Society and of microbiology, by initiating interactive events

of their own or participating in Society-led activities. We have a range of opportunities to help you get involved and collaborate with other Champions.

We are looking to expand our Champions Scheme and would be delighted to hear from you.

Here is what our Champion Pankaj Chaudhary thinks of the scheme:



Pankaj Chaudhary

I joined the Society to share my knowledge and experience of microbiology, in particular mycology, with the general public and within my local communities. I believe the Champions Scheme is a fantastic platform to share science and opportunities. I was encouraged to join the initiative by fellow Champion Manoj Pradhan. There are so many resources and opportunities available to me as a Champion, and I enjoy sharing this alongside my expertise with colleagues and students alike.

*Pankaj Chaudhary
Sagarmatha Choudhary Eye Hospital, Nepal*

If you would like more information on becoming a Champion, contact our Membership Officer Alison Quinn a.quinn@microbiologysociety.org.

Early Career Microbiologists' Forum update

Welcome to the Early Career Microbiologists' (ECM) Forum update. The 'Engaging Microbiology' theme of this issue is a topic that will resonate with many of our ECM members. Our ECMs are the driving force behind many of our engagement projects across the Society. I am delighted to have the opportunity to highlight some of their work in this article and update members on the ongoing work of the ECM Forum Executive Committee.

Rebecca McHugh

Firstly, I would like to draw your attention to one of our ECM Forum Members, Dr Linda Oyama, who has been working to deliver STEM workshops focusing on microbes for primary schools. Details of Linda's work can be found in her article titled 'Inspiring the next generation of microbiologists through outreach: early beginnings matter!' on page 24. Our members at the University of Strathclyde have also recently developed a video game titled 'Dr Dirt' which aims to teach children about antibiotic discovery from microbes. This is suitable for children aged eight and above and is available on the App Store. Many of our members also planned activities for British Science Week and the International Day of Women and Girls in Science. These events showcased the creativity of our members who strive to engage the wider community with the core values of our Society.

In 2021, the ECM Forum Executive Committee set out to assess the impact of COVID-19 on ECMs. We aimed to understand in detail how our members had been affected with the aim to generate a constructive support strategy on behalf of the Society. Feedback from our panel discussions and surveys revealed the extent to which ECMs were disadvantaged by the pandemic. Our members consistently emphasised that the direct impacts of lockdowns such as reduced access to laboratories were a small fraction of a multifaceted problem. Forum members were particularly concerned about limitations on networking and training opportunities and the heightening of pre-existing disparities for parents and carers. It was clear from our members' feedback that the pandemic has magnified issues already present within academia, particularly around mental health. This has resulted in growing numbers of people leaving academia, meaning we are at risk of losing some of our most talented people. With increasing numbers of ECMs expressing their concerns, it was decided that the Society was to express



gorodenkoff/iStock

its support for ECMs in the form of a position statement. I am pleased to say that this position statement was released in November 2021 and is titled 'Safeguarding the future of the microbiology research and innovation workforce' and can be accessed online (microb.io/33Pk6YG). On behalf of the ECM Forum Executive Committee, I would like to thank everyone who contributed to our discussions.

As I write this article, colleagues behind the scenes are working tirelessly to organise the return of our in-person Annual Conference, which has been greatly anticipated. We are planning our annual ECM Networking event on the Sunday night preceding the conference and are looking forward to meeting Forum members face to face for the first time in three years. I hope this will lead to a new cohort of microbiologists joining our Forum and many more networking opportunities in the future. Stay safe everyone!



Rebecca McHugh

ECM Representative for Impact and Influence Committee, ECM Forum Executive Committee

Early Career Microbiologists' (ECM) Forum Summer Conference 2022

12–13 July 2022, Sheffield, UK

Abstract deadline: **26 May 2022**

Early bird registration deadline:
7 June 2022



#ECMConf22



Coccus Pocus 2021: the thrilling scary story competition returned last autumn!

In October 2021, the Department of Biomedical and Forensic Sciences at the University of Hull launched for a third time an exciting scary story competition for Halloween: Coccus Pocus 2021!

The competition was supported by the National Biofilms Innovation Centre as part of their #BiofilmAware campaign, which is all about helping people to understand what biofilms are and why biofilms are so important.

The contestants were encouraged to write a short horror sci-fi story between 500 and 2,000 words, including antimicrobial resistance and/or microbial biofilms. The story evaluation committee ranked the stories according to the intrigue of their plot, use of language, character description and scientific soundness.

18+ age group

The first prize (a £100 Amazon voucher) was awarded to Ms Lizzy Cairns, a microbiology MSc student from the University of Glasgow. Her awesome story, *The slime of the ancient mariner*, is about a nautical journey where the crew members encounter an ancient oceanic biofilm with catastrophic intentions.

Ms Aleya Lumsden, a biomedical science undergraduate from the University of Warwick received the second prize (a £30 voucher) for her story *Golden Berries*, where a group of bacteriophages travel through a slimy *Staphylococcus aureus* biofilm.

Finally, Ms Rhianna Lee, again an undergraduate student from the University of Warwick, was given the third prize (a £20 voucher) for her story *Dissociation*, which tells us the tale

of a patient suffering from an antibiotic-resistant black fungus that causes some very weird symptoms.

12–17 age group

All winners in this group were from Engineering UTC Northern Lincolnshire and were motivated by their creative engineering teacher, Zoe Henschen.

The first prize (a £100 Amazon voucher) was awarded to L. Palmer for the story *The plane crush*, the second prize (£30) to J. Dicken who wrote *Biofilm World* and the 3rd prize (£20) to G. Healer for *Bio-film: A horror story*.

This year, our fantastic network of Coccus Pocus Ambassadors grew from four members to 15, including new ambassadors from France, Greece, Malta and Denmark! Their enthusiastic contribution led to a lot of much scarier story submissions this year (19 compared with four received last year).

In addition, nine of these 19 stories came from a secondary school (age group 12–17). Until now, all entries were from university students, so we were delighted to see school pupils participating too! A microbiology taster session at the University of Hull was offered to the three young winners and will take place this spring.

Dr Georgios Efthimiou

University of Hull, UK

Co-Editor-in-Chief for *Access Microbiology*



Lizzy Cairns



Aleya Lumsden



Rhianna Lee

Coccus Pocus will run again in October 2022. Can you think of any biofilm- or AMR-related scary stories? Would you like to be one of our Coccus Pocus Ambassadors? And which university or school will claim our next trophy? Read more about the competition and download the winning stories on our website (microb.io/coccuspocus2021).

Member Q&A: Shakib Alhagh



Shakib Alhagh

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

Where are you currently based and what is your role?

I am an early career microbiologist (ECM) and completed my postgraduate studies last year at University of Nottingham.

In what area of microbiology do you specialise?

Clinical and molecular microbiology. I mainly studied infectious diseases, infection prevention and bacterial secretion systems.

Tell us about your education to date.

I obtained my undergraduate degree in general microbiology in Iran and then moved to the UK to continue my education at the School of Life Science, University of Nottingham. Here I completed an MSc in clinical microbiology under the supervision of Dr Karl Wooldridge, as part of his research group focusing on characterising the role of a novel operon of *Neisseria meningitidis* involved in iron uptake and virulence. I then completed my PhD in molecular microbiology under the supervision of Professor Kim Hardie and Dr Chris Penfold, working on characterising the role of potential accessory factors that facilitate secretion and gene regulation of the EspC and AaaA autotransporters.

When and why did you first become interested in microbiology?

I was a curious child, growing up in a medical family, and was fascinated by the complexity of life. I became interested in the microbial world and causes of infectious diseases in high school when I used a light microscope for the first time.

As an ECM, what are some of the professional challenges you face and how do you overcome these?

Currently, I am exploring my career options in academia, industry, clinical settings, or the natural world. I think making an honest self-reflection based on my educational background

and willingness to conduct teaching, research and lab work as a future career will help me to make a clear decision.

Has the COVID-19 pandemic impacted your career and, if so, how?

Years of work experience and Health and Care Professions Council registry are major challenges for ECMs in finding their desired job opportunities after completing a PhD. I think that finding a personal research interest, career consultation sessions, team working, collaboration, mentorship and work visa support in each sector can help and facilitate the application process for graduates in this regard.

Do you have any role models, if so, who?

My family and all my teachers, supervisors and mentors that helped and supported me during my academic journey.

If you hadn't gone into science, what career path do you think you would have chosen?

Working in a book shop, opening a food start-up, or exploring as a travel writer!

What has been the highlight of your career so far?

Learning valuable academic and transferable skills in microbiology.

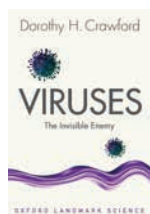
What do you hope to achieve in your career in the future?

The world of life sciences is changing incredibly fast, and it is sometimes challenging for an ECM to keep up with the science and technology. I hope to create balance, meaning and vitality between my work and personal life in the future.

If you would like to be featured in this section or know someone who may, please get in touch via getinvolved@microbiologysociety.org.

Reviews

Read excerpts from the latest book reviews below. To read the full reviews, and for more reviews, please visit our website: microbiologysociety.org/MTMay2022Reviews



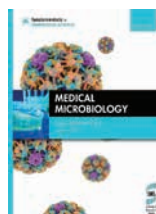
Viruses: The Invisible Enemy

By Dorothy H. Crawford
Oxford University Press (2021) £9.99
ISBN: 978-0-19284-503-0

Professor D. H. Crawford expertly summarises relevant scientific facts, interesting information and diverse examples of human viruses that are known to date due to their medical importance. Her writing style is truly engaging as it allows the reader to navigate through complex information with ease, with her stories flowing seamlessly from one part to the next. I would thoroughly recommend this book to anyone interested in understanding general aspects of modern virology in a clear and delightful manner.

Karen Campos-León

Former Fellow Postdoctoral Researcher at the University of Birmingham, UK



Medical Microbiology, Third Edition

By Michael Ford
Oxford University Press (2019) £34.62
ISBN: 978-019881-814-4

The book is a valuable resource for any biomedical student studying Microbiology and eager to learn about the practical implications of their knowledge. It covers diverse areas of Medical Microbiology, starting from the basic understanding of culture media and commonly used microbial tests to the advanced knowledge of bacterial pathogenesis and antibiotic resistance through its thoughtfully structured chapters. This third edition is a valuable update and just like the previous editions, I believe it will also be a useful textbook for students of Biomedical Sciences.

Sudeshna Saha

University of California San Diego Health, USA



Infectious Pathogens and How We Fight Them

By John S. Tregoning
Oneworld Publications (2021) £12.79
ISBN: 978-0-86154-123-2

Dr John S. Tregoning's expertise in the field of microbiology is reflected in this book. He has depicted historical and present scenarios of many infections, as well as the strategies that should be employed to battle them, in a methodical and persuasive manner throughout this book. This book is written in such a way that even someone with no prior knowledge of science may grasp it. This book is the essence of all scientific discoveries and innovations.

Manita Paneri

Centre for Interdisciplinary Biomedical Research, Adesh University Bathinda, India



Global Health Security a Blueprint for the Future

By Lawrence O. Gostin
Harvard University Press (2021) £36.95
ISBN: 978-067497-661-0

This book has addressed the central question of global health security due to the series of pandemics experienced to date, with a special focus on the most recent and deadliest, COVID-19. This book provides special insight for understanding beforehand preparation and planning to cope with future pandemic threats due to the outbreak of deadly pathogens. I strongly recommend this book to diverse readers, especially students, teachers, scholars, advocates and young professionals involved in global health security.

Sweta Karan

University of California, San Diego, USA

Comment: changing with the changes

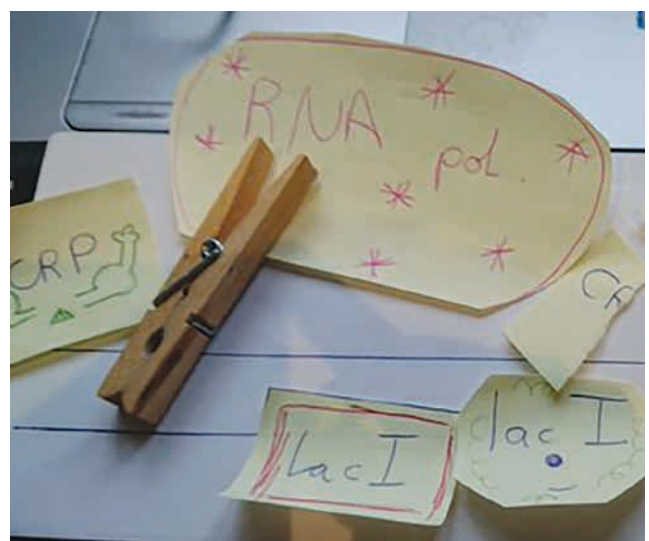
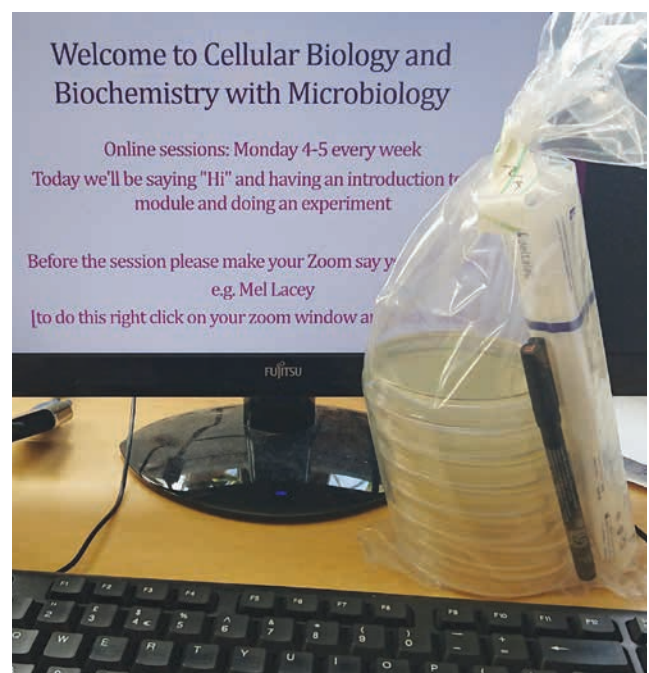
Mel Lacey

Our nine-year-old read *Twenty Thousand Leagues Under the Sea* with his class during the pandemic. The motto of Captain Nemo's Nautilus *Mobilis in Mobili*, moving in the moving thing or changing with the changes, became our household motto in the dark days. A much-needed mantra that when everything was constantly changing we could roll with the storm, as long as we knew what direction we needed to be going in. As an academic, the direction was the same as it always has and always will be; to look after and educate all my students the best I can and support others to do the same. The pandemic has changed how we teach and work, but more fundamentally, we have changed as individuals, educators and researchers and our students have changed too, with their education being impacted unimaginably.

How have students changed? We have all changed in unquantifiable ways, but perhaps it is important to recognise what hasn't changed. The overall narrative from our students as to what motivates them is the same now as before the pandemic. Students are motivated by the content they feel is most relevant to them and their chosen careers. Students are engaged by lecturers that enjoy teaching and who are enthusiastic about their subject; I find this reassuring, entirely reasonable and utterly achievable.

Our mode of delivery has changed so much in an incredibly short period of time; from pre-pandemic on-campus teaching to entirely online, through hybrid teaching to predominately face-to-face teaching for most – *mobilis in mobili*, moving in the moving thing, changing with the changes! Student feedback across the sector indicates a desire to be back on campus but also to have online access to material and content. So how do we accommodate this juxtaposition and provide good learning experiences for students?

Firstly, we need to remember students are a heterogeneous group. The provision of online materials has increased the engagement and attainment for some specific students, often neurodiverse students, those with complex home lives and



Teaching microbiology online via Zoom. Mel Lacey

those with disabilities. There is now a significant number of students with underlying health issues who are not wanting to catch COVID as restrictions ease and campus' fill up again. For me, it's important that we look out for these students and maintain as much adaptability as we can to support them, especially those in already marginalised groups.

Secondly, we know as educators some elements of our teaching has been better online. Recorded content on how to write a good CV, tutorials on using pieces of software or doing calculations are more helpful to students than a single face-to-face teaching session. Recorded content allows students to engage with material when they need it, they can digest it in small chunks and return to it at a later date: live help sessions can provide additional support for specific students. Resources such as Lecturemotely ([lecturemotely.com](https://www.lecturemotely.com)), which expanded massively during the pandemic, remain an excellent source of online materials and ideas.

As well as teaching, assessment has changed massively – *mobilis in mobili*, moving in the moving thing, changing with the changes! Open-book, online exam assessments were used extensively throughout the first 18 months of the pandemic, with many institutes retaining them rather than returning to closed book in-person exams. The use of open-book exams has amplified conversations around the purpose of exams and other assessments. Many (myself included) argue that we live in an information world, so students filling their minds with information to repeat in an assessment isn't an important skill, and instead, we should focus on students understanding what their knowledge means and how to apply it. Many (myself included) are concerned that open-book exams favour those with a quiet place, surrounded by their notes with a stable internet connection to take their exam; they at best reward those who can google the quickest and at worst risk prolific collusion and cheating. On balance, I think open-book exams are a good thing, so how these assessments are designed is critical to ensuring fair and appropriate assessments. There is a sizeable amount of work being undertaken in the pedagogy community on best practices for open-book assessments, including the 'How to write an ungoogleable question' blogs by Dr David Smith.

I feel working during a pandemic, through home schooling, class bubbles bursting, COVID and isolation, has been a form of academic extreme training. Like how runners

train at high altitudes, just on Zoom. I think, as is often seen after periods of acute change, there'll be a swing back in the narrative to returning to the old ways. This is unlikely, and instead we'll see a new type of higher education teaching and learning landscape emerge. We aren't through the changes yet; that's OK though, *mobilis in mobili*, we know which direction we are going.

Further reading

Dave the Smith. How to write an ungoogleable question part 1; 2021. <https://davethesmith.wordpress.com/2021/08/12/how-to-write-an-ungoogleable-question-part-1> [accessed 3 May 2022].

Dave the Smith. How to write an ungoogleable question part 2; 2021. <https://davethesmith.wordpress.com/2021/08/19/how-to-write-an-ungoogleable-question-part-2> [accessed 3 May 2022].

About the author



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Mel Lacey is a Senior Lecturer in Microbiology in the Department of Biosciences and Chemistry at Sheffield Hallam University. Her role at Sheffield Hallam encompasses teaching Microbiology across the undergraduate and postgraduate curriculum, being co-Admissions Tutor for undergraduate degrees and undertaking microbiology and pedagogy research. Her research spans design and delivery of antimicrobials, microbiome: host interactions and environmental microbiology through to citizen science and the accessibility of science in education and the wider community.

Why does microbiology matter?

Because it impacts so many elements of our society, from our health to biotechnology; microbiology is everywhere.

What do you love most about your job?

I love that higher education has the power to transform lives, and I'm really grateful I can be a part of those inspirational journeys (and telling people that microbes are cool is a close second).