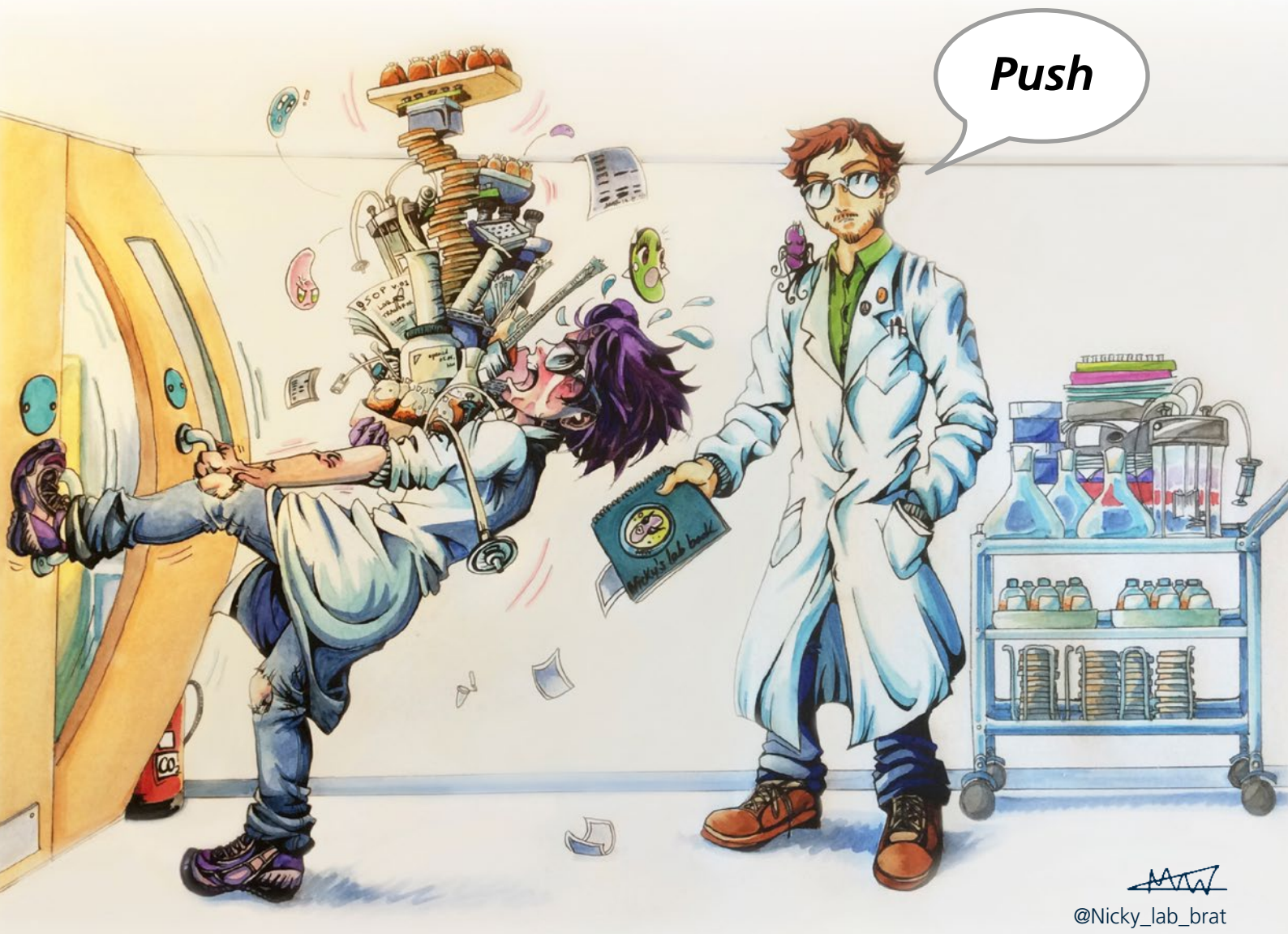
JUNE 2020 | VOL. 21 NO. 2 | ISSN 1479-2699

microbiologist



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Copy dates

Vol. 21 No. 3 September 2020
Wednesday 8 July

Vol. 21 No. 4 December 2020
Wednesday 7 October

Vol. 22 No. 1 March 2021
Wednesday 7 January

Vol. 22 No. 2 June 2021
Wednesday 14 April

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Microbiologist is published quarterly by the Society for Applied Microbiology, a registered charity. ISSN 1479-2699.

Mobilis in mobili

The motto of the Nautilus from the Jules Verne novel *Twenty Thousand Leagues Under the Sea* is *mobilis in mobili*, which roughly translates to 'moving in a moving thing' or 'changing in the changes'.

We are all changing during this evolving pandemic; human development doesn't just stop because we have certain restrictions placed on our freedom. Taking a cue from SfAM Early Career Scientists (ECS) Committee Secretary James Williamson's blog *Board games: activities for self-isolation,* I ripped the cellophane off the Dungeons and Dragons starter set I got last Christmas and sat staring at two weighty manuals and some pyramid dice – no toy! I was expecting a mini figure at least. Anyhow, I have promised to read the instructions and James has agreed to play a virtual mini game with me before sending me off alone into the world of role play and fellow geek-hunting.

All of us are navigating boredom, love, work, fear, anger, jealousy and everything in between under the current social distancing rules. Stress and anxiety levels range from mildly raised to through the roof and hundreds of thousands of people are grieving the loss of a loved one. Ask us what we are looking forward to this year and you are likely to see sadness in many eyes. The pandemic has taken away our plans and rewards and given us a 'new normal' for an uncertain future.

What we all need right now is to have something to look forward to in the future, something that can give us the motivation and persistence to keep moving forward during these difficult times.

This brings me back to James and to the rest of the ECS Committee. Since lockdown, this group of early career microbiologists have done everything they can to identify ways to help scientists of all levels remain relevant, stay informed, network, learn and have some fun. That is why SfAM's ECS Committee are looking at March 2021 as the month for the **ECS 10th Anniversary Research Symposium**. Online booking and the abstract submission form will be available in August and the location for the symposium will also be announced. It may not be tanning in Cape Verde, swigging beer in Bruges or dancing in Ibiza, but hopefully it will finally be a chance to meet up, show off your research, listen to exciting keynote speakers, or just sit back and learn.

Is this overly optimistic? Maybe. Will the event be cancelled if there is still any health risk for you or your loved ones from the pandemic? Absolutely. Will any registration fees be fully refunded if cancelled or moved online? Definitely.

The ECS will carefully consider all these questions and all delegates will be made fully aware of how they can participate in plenty of time. Be it in person, online or a mixture of both, the ECS 10th Anniversary Research Symposium 2021 will be the biggest and most exciting yet.

Successful societies are always built by people working together with a common vision. It keeps us sane and purposeful at the same time. Our Society, built by applied microbiologists, has just this ethos.

Paul Sainsbury
Editor

Now is the time to take your place and make a difference

Jana K Schniete

Edge Hill University

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None of us have all the answers

Well, for my last President's column we find ourselves in definitely peculiar times! I am often promoting microbiology as a subject area and saying just how important it is to make sure that politicians, policymakers and the public realise just how important we are as a group of scientists.

However, recent global events have brought the importance of microbiology and vaccination into extremely sharp focus. Over the past few years I have been lucky enough to be collaborating with a group based in the USA (EcoHealthAlliance). We have had PhD students looking at various aspects of the risk of emergence of paramyxoviruses and coronaviruses in China. This work, while extremely interesting, seemed a long way away from what we are now facing. In December last year, members of the team published a paper discussing human and animal interactions and the potential for bat coronavirus spillover amongst residents of rural Southern China! Little did we know of what was about to emerge in reality. It was from this point that the world became aware of the situation occurring and developing in Wuhan city and Hubei province in China. It became evident soon after this point that the disease was spreading or indeed had spread across mainland China. This of course led to the need for explanations and questions from journalists as the world tried to understand and get some context as to what was happening. Initial queries circled around "what is this thing?", "where has this come from?" and "how has this happened?"; all these questions needed answers and to be honest we did not necessarily have all the answers. The questions then moved onto "what is the treatment?", "will people die?" and then "will it come over here?" It is really interesting looking back at how the questions have changed and indeed so have the answers as time has progressed and our information and understanding have developed. The information in the media has moved from this being a situation that is largely contained in China, through to contained in Southeast Asia, then Europe and onto the Americas when finally, the pandemic was formally announced. Interestingly, during this time both here and across the world, the level of perceived risk moved from low to high across nations of the world and so did the perception of risk to each nation. Again, this was reflected in the questions posed by the journalists. Now questions were being asked about treatment prospects, survival rates, risk groups and how countries could contain/control the situation they found themselves in!

Mark Fielder
President of the Society for Applied Microbiology

From a social science perspective it has been fascinating to observe how, in general, people have broadly accepted the 'infection control' measures as lockdown is implemented in the UK and globally. In addition, the social conditioning/behavioural change we have all been asked to undertake with social distancing has been interesting to observe. This is of course a massive change to our behaviour and has largely been accepted by people and is now expected (by the population); this sort of behavioural change on this sort of scale is pretty much unprecedented. I remember being asked by a journalist right at the beginning of the Wuhan lockdown, if the type of measures being seen in China (the lockdown) would be tolerated in the UK? I answered that I thought they probably would but had the caveat that the social structures of the two countries were markedly different! I am very pleased that we in the UK and the West have adopted the measures required of us to try and limit the time that this virus impacts upon us, our health service and takes people from our communities.

The basis of questioning from journalists has now moved towards the importance of testing and PPE, probably with testing being at the forefront of questions being asked. These range from "what are the tests?", "how do I get a test?", "why are we not testing everyone?" and questions around why some tests are not being rolled out, such as the famed antibody test. Interestingly, this question is raised by as many academics and scientists as journalists and the public. It has certainly been controversial. Will mass testing solve the spread of disease? Is full community testing (i.e. testing everyone) an important thing to do? There are many points of view and I am not going to sit as judge and jury. I will say that I have seen a general (not complete) split in views between colleagues and friends of mine who are more academically based when compared with those on the clinical frontline or at least close to it. I guess the lesson here is that we need to listen to different perspectives and recognise different skill bases. If there is one thing that SARS-CoV-2 has shown us, it is that NONE of us have all the answers. We should do what us scientists can do really well: come to some sort of consensus as hard as that may be!

So to bring us to the current situation (at the time of writing), we have had a glimmer of hope with the announcement of two vaccine candidates potentially going into human trials in the very near future. This is of course a fantastic achievement for an infection that we first heard of back in January of this year. We are now at the stage where human trials are being initiated and we will get some evidence as to whether these vaccine candidates can illicit the immune response we require and also there are no negative effects on the host. These are very exciting times as a vaccine is potentially on the horizon; however, we need to take into account the comments of the lead scientists; vaccine development is plagued with points where they might fail in their development. Despite these important caveats both researchers are buoyant and confident about the potential of these vaccine prospects – here is hoping!

Finally, I would like to use this column to make my last addition as the Society President in the form of a massive thank you. We have all clapped, cheered, praised and lauded the doctors, nurses, carers, NHS admin staff, sanitation workers, cleaners, utility workers, delivery workers and all the other frontline keyworkers, and indeed so we should and do so with vigour. They are all heroes; they all keep us going and indeed alive. There is a group that also gets lost in this praise a little and they are our own! The biomedical scientists (of all grades), the clinical scientists and all the research scientists that are intrinsic to our testing responses, routine services and of course ongoing research. We all thank you – you are heroes so thank you for all your hard and vital work!

Thank you.

Supporting an unknown future

We are currently living through extraordinary times. As a society of applied microbiologists, we are aware that many of our members are contributing to the ongoing SARS-CoV-2 pandemic in countless ways, through laboratory testing to providing evidence and expertise to government organisations, as well as robust evidence-based communication via traditional and social media. On behalf of SfAM I'd like to sincerely thank our members for the work that you are doing to manage this crisis.

Welfare is key

The welfare, health and safety of everyone who contributes to our work is paramount. Because of this, we took the decision to cancel the events we had planned for 2020. I was struck by the reaction of our Early Career Scientists Committee to the news that their Research Symposium had to be cancelled – their resilience and tenacity was demonstrated by the opportunity they provided to all poster presenters to display their posters online. These posters and flash presentations were then highlighted via Twitter on the day the Research Symposium had originally been due to take place. This was the Society's first Twitter poster conference, and provided participants with numerous networking outcomes, as well as an article for the *Microbiologist*! We are now exploring options to take many of our scientific events online.

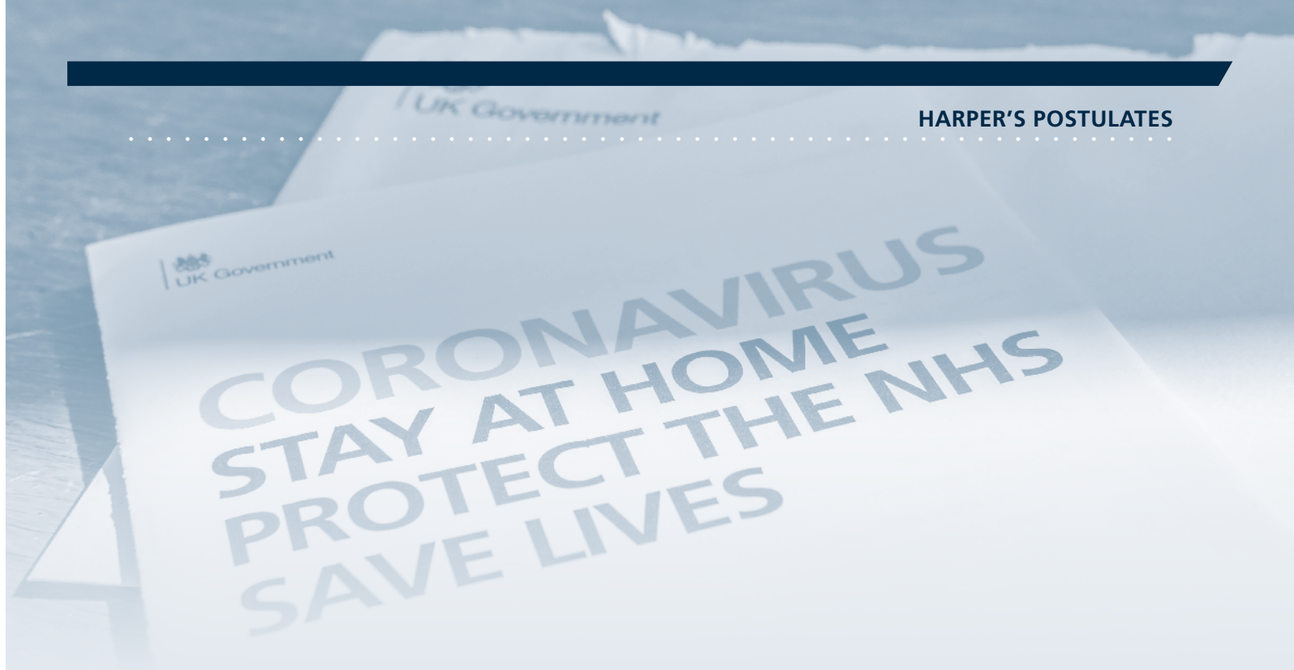
We have equipped all team members to work from home. Flexible and home-working is something that, prior to lockdown, many of the team were used to doing a few times a week. However, for others working from home was a significant change. Thankfully, the mental health challenges of the current situation are openly discussed online and amongst the team. To support everyone we provide regular catch-ups, the provision of welfare information and resources, and I am operating a virtual open door policy whereby the team are welcome to contact me at any time to raise concerns or just talk about the weather! We have provided equipment and furniture to ensure all team members are as comfortable as possible whilst working at home.

Supporting our members

During April we held a number of focus group meetings for members to discuss with us the challenges they are facing as a result of the SARS-CoV-2. The results of this, together with the feedback we received from a members survey, will inform future activities to support our members through this difficult time.

We are keen to hear from all members to find out how the SARS-CoV-2 pandemic is affecting you and the ways we may be able to support you during and after the crisis.

Lucy Harper
Chief Executive of the Society for Applied Microbiology



If you'd like to share your story with the team here, please do get in touch on: **communications@sfam.org.uk**.

We are also exploring various potential grant support opportunities with our members whose work has been disrupted by the pandemic and if you have anything to contribute to these discussions, we would welcome your input.

Journals

We have made all articles that focus on any aspect of SARS-CoV-2 published within the SfAM journals portfolio accessible to all without an embargo period. All these articles are published through fast-track peer review and at no cost to the author to ensure all information that contributes to the current crisis is immediately and freely available.

Continuous monitoring

It is vital that we remain up to date with this fast-moving situation, not only from a scientific perspective, but organisationally. We are working hard to ensure the appropriate steps are taken to maximise productivity alongside the welfare, health and safety of all who contribute to our work.

A message I've seen circulating in various forms via social media is something I've passed on to the team and I hope will benefit our members as well: "*You are not working from home, you are living through a pandemic and trying to get some work done. Be kind to yourselves.*"

NEW MEMBERS OF THE SOCIETY JUNE 2020

Canada
C. Lau

Hong Kong
H. Luo

India
P. Srivastava
M. Sogani
J. Mankotia

Ireland
F. Walsh
M. Roa

Nepal
P. Chaudhary

Netherlands
S. Geisen

New Zealand
S. Kumar

Nigeria
T. Ugwuoji
A. Chere
U. L. Ifeanyichukwu
T. Cookey
I. Okoroafor
O. A. Ajayi
M. Nnorom
Y. Obafemi
P. Akinduti

Saudi Arabia
A. Al-Judaibi

Spain
D. Correa Galeote

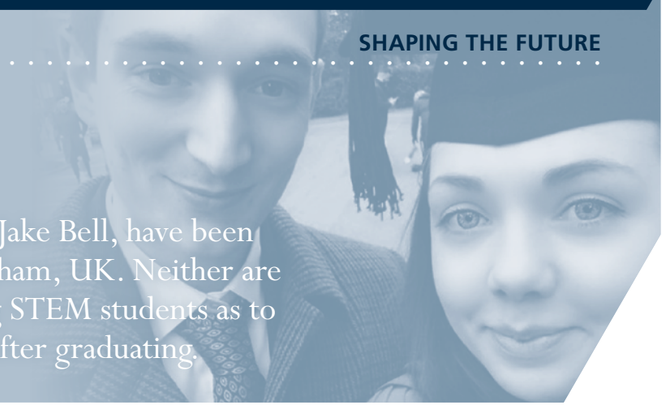
United Kingdom
F. Ukachukwu
W. O'Neill
A. Fuller
A. Stuart
H. Boostrom
P. Owuamalam
T. Cummins
M. Shivkumar
D. Barreiros Jorge
P. Prasongpholchai
G. Kaur
K. Parkin
A. Salmane
M. Toribio-Mateas
J. Blanco
J. Martinez Perez
B. Gilbride
E. Garcia-Gutierrez
N. Miguel-Vior
S. Arnaouteli
A. P. Guevara Cerdan
R. M. Ford
D. Cooke
L. Cossu
D. Bonini
L. Sheppard
H. Taylor
M. Clark
A. McCloskey
D. Chrysostomou
R. Ibrahim
T. Thomas
K. Le Cocq
A. Masi
P. Mariathasan
R. Whelan
N. Daud
K. Parker
D. Latousakis
M. Taggart
S. O'Shea
D. Ndeh
C. Nesbitt
M. Brown
C. Fanitsios
K. Speed
J. Domínguez Robles

United States
O. Edna Mokeira
A. Freeman

To PhD, or not to PhD; that is the question

Although the number of students completing graduate degrees has increased in recent years, the number of academic jobs has not kept up with the pace of graduating students, making grad-school hypercompetitive and increasing the pressures to maximise impact via publishing multiple papers. For many, the love of research and being at the bench is enough motivation to keep working towards an academic position, but for others, the opportunity to apply their scientific training elsewhere is an attractive option.

SHAPING THE FUTURE



Georgia Jones and her boyfriend, Jake Bell, have been together for 6 years and live in Egham, UK. Neither are strangers to the uncertainty facing STEM students as to where their employment will lie after graduating.

Georgia Jones

Kingston University aluma, UK currently on the job hunt

Like many millennials, I aspired to have a fulfilling career that I was passionate about and qualified for. Having a morbid fascination with death and decay, forensic biology seemed an apt choice.

Death is a process, rather than an event. Everything you are and everything you are made of, all those minute molecular processes that keep you happily ticking over while you're sipping your coffee, they don't just stop. It takes time for things to shut down. Paramedics will tell you – as they did me when I was volunteering with St John Ambulance – if someone has died, watch what you say around them for a few minutes as they may still be able to hear you.

I was about 3 years into my BSc in forensic biology when I realised how repetitive forensic science is. It's taping every centimetre of a pair of trousers for hours looking for the tiniest hair in the world, spraying chemicals on mountains of clothes desperately trying to detect something important or remotely interesting like semen or blood and then the ultimate in fun: sifting through dirt. Now, while the work that forensic scientists do is vitally, unequivocally important to our legal justice system, the nature of this painstaking work was not for me. Scared off the forensic route, I decided to revisit some other parts of my degree I had really enjoyed – molecular biology and pathobiology.

A master's degree in cancer biology seemed to tick boxes for me in the hope of studying something I found fascinating. The way cancer migrates around the body would make you think that in some way it is sentient, knowing and nefarious in nature (which is terrifying). It didn't take long, however, before I started to doubt my choice again. Had I made another mistake? Most people on the course were from biomedical science backgrounds and heading straight for GSK; the others were medical doctors specialising in oncology. I didn't really fit into either of these categories.

I undertook a 3-month independent research project during my MSc on the effects of the novel epigenetic drug zebularine on ovarian adenocarcinoma cell line SKOV 3 growth – which, in some parts, was actually quite interesting. My lab expertise shone through when I did what my supervisor called an 'Alexander Fleming' by growing some sort of fungus in my tissue culture flask. The rest of it was PCR, qPCR, spin down, rinse, pipette, spin down, rinse, pipette, electrophoresis, spin down, rinse, pipette. Repeating PCR experiments over and over had me crying tears of frustration into the buffer. The fiddliness and highly strung nature of the work made me want to pull my hair out. I hated lab work. Really, really hated it (and wanted to keep my hair). This realisation brought a gut-deep level of panic within – if I hated lab work, then what the heck was I doing a master's in it for?

I didn't know what I had in mind after my master's and, to be honest, I don't think I had ever thought that far ahead. So, one evening after my graduation, I sat in my luxury Edwardian student house with all its original features (dilapidation, no heating, rising damp and curious mice), opened my laptop and began to job search. What I found was hugely underwhelming and left me cold – not unlike my luxury Edwardian student house.

I love and appreciate how many of you (especially my boyfriend Jake!) find joy, interest and passion in benchwork and I must admit to being a little jealous of that. However, I started to realise that being different is a strength, not a weakness and I've made the brave decision to jump off the academic treadmill. And, whilst it may feel like I am doing a 'PhD-by-proxy' living with Jake, I will make my mark in science another way.

Jake Bell

Royal Holloway, University of London, UK

I caught the research bug early. In my first year as a BSc Human Nutrition undergraduate, I worked on a public health research project that sought to determine the compliance of the 'food environment' with government guidelines on healthy eating. This resulted in my first co-authored paper and gave me real-world insight into how research projects are planned, conducted and distributed.

I was hooked.

Studying for an undergraduate degree that broadly covered so many fundamental aspects of biology – from molecular and cellular biology through physiology and immunology – was so beneficial and really opened my mind. It was in the second year when I got my first taste of microbiology. The module included plenty of laboratory practical sessions, including the catalase test. I vividly remember looking at the air bubbles rising in the tube and admiring how a process that seemed so simple was really the result of staphylococci having evolved a biochemical response to a threat within its environment. To put it another way, I liked the way benchwork offered a way to observe the theory we were taught in class. I again took advantage of summer placements in 2016 and worked on a project exploring the carriage of antibiotic-resistant microorganisms in beef products.

It was these subjects inspiring my interest, the excellent mentors spotting my potential and some canny summer projects that led me to undertake a 10-month research placement at Kew Royal Botanical Gardens working on plant–microbe interactions. Having my own project to work on, learning new experimental and data analysis techniques, writing papers and interacting with numerous researchers at various stages of their careers was an incredible (and daunting) experience. The placement cemented my budding desire to pursue a PhD. This was the year I joined SfAM and attended their Early Career Scientists (ECS) Research Symposium and annual conference. I also met the brilliant ECS Committee, who to this day remain a constant source of inspiration and support.

Now doing my PhD, I still love my benchwork and am constantly learning. I have rapidly become familiar with a wide range of scientific approaches in microbiology, crop science, genetics, computational biology and more. It's so cool! I'll sometimes even swing by the lab during weekends to check on how my experiments are going and not because I must, but because I want to.

If you couldn't tell already, I love everything about my PhD.

I'd be lying if I didn't say I wasn't concerned by the grim statistics of only 3–4% of PhD students securing permanent academic jobs. I am. But having a PhD part-funded by an industry partner allows me to truly see the industrial applications possible from the work I am doing. Ultimately, I think we as science graduates are uniquely suited to using our skills to find and contribute to meaningful and interesting work in a variety of settings, both within and outside academia. After all, learning to solve complex problems is what a PhD is all about.

Like many in my position, I don't know what my post-PhD employment will look like, but the enjoyment of lab work and research keeps me following the academic path whilst I try to take on additional non-academic challenges to expand my skill set.

Trace gases, microbes and life beyond Earth

Gary M King
Department of Biological Sciences, Louisiana State University, USA

Trace gases in the Earth's atmosphere, e.g. carbon monoxide (CO) and hydrogen, serve as fuels for microbial metabolism in extreme environments, and they might also sustain extraterrestrial metabolism on Mars or elsewhere. By definition, trace gases individually make up ≤1% (or 10,000 parts per million, ppm) of planetary atmospheres. In spite of these low concentrations, the significance of the Earth's many trace gases extends far beyond what their abundances suggest. Carbon dioxide (CO_2, about 400 ppm) accounts for a large fraction of the gases that cause the 'greenhouse effect', known more properly as 'radiative forcing', and represents a fundamental unit of the carbon cycle. Methane (CH_4, about 2 ppm) also contributes to radiative forcing and plays significant roles in atmospheric chemistry. CO (about 0.3 ppm) determines the oxidative state of the atmosphere and partially regulates concentrations of many organic volatiles, including CH_4.

Results from more than a century of research have not only revealed the phylogenetic, physiological and ecological diversity of trace gas-utilising bacteria, they have shown unequivocally that these bacteria have largely determined the composition of the atmosphere throughout most of the Earth's history. Indeed, they are responsible for the atmospheric chemical disequilibrium that famously led James Lovelock, a primary originator of the Gaia hypothesis, to claim that the equilibrium state of an atmosphere indicates whether a planet likely does or does not harbour life. Relative to Earth, no other planet in the solar system supports an atmosphere far from equilibrium so, following Lovelock's logic, no other planet likely supports life, at least not at a scale large enough to impact the atmosphere.

Nonetheless, the search for evidence of past and extant life on Mars has intensified over time rather than diminishing, fuelled in part by discoveries that support the existence of ancient oceans and even contemporary liquid water. While future discoveries might yet document globally extensive life that could have affected Mars' atmosphere early in its history, it is evident that extant life, if it exists, is neither globally distributed nor capable of generating a chemical disequilibrium in the atmosphere. Microbial life might exist in Mars' subsurface but, if it does, its impact on the atmosphere appears to be limited to infrequent enigmatic puffs of CH_4 that have little overall atmospheric chemical consequence.

In spite of extremely challenging conditions, relics of ancient microbial life might yet persist at or near the regolith surface. If so, any extant populations or communities would likely occur at very low abundances in isolated patches. Though any such communities would be too small to noticeably affect Mars' atmospheric composition, they might nonetheless depend on the atmosphere for sources of carbon and energy. CO_2, which accounts for 94.9% of Mars' atmosphere, represents an obvious source of cell carbon for microbes that function as chemolithoautotrophs, but sources of suitable reductants are unclear.

Ferrous and metallic iron occur in various mineral phases found on Mars, but the extent to which they might be available as physiologically relevant reductants has not been adequately evaluated. A model study with *Methanothermobacter wolfei* revealed a potential role for metallic iron in methanogenesis, while a study with *Acidithiobacillus ferrooxidans* documented growth on ferrous iron-containing minerals in a Mars regolith simulant. However, the extent to which these reactions might occur on Mars, where in particular and under what conditions remains largely speculative.

In contrast to the patchiness in the regolith of potential solid or aqueous substrates that could be locally depleted over time, Mars' atmosphere represents a relatively well-mixed, constant and ubiquitous source of substrates that could be used by putative microbial populations colonising habitable regions of the surface or near surface. Since habitable zones appear quite limited, any populations that colonised them would be too small to impact atmospheric composition, but they could be sustained by trace gas consumption.

CO is an especially intriguing candidate gas, since it is well known as a source of energy, and in some cases cell carbon, for a wide range of terrestrial bacteria, from aerobes to facultative anaerobes and obligate anaerobes. The former two groups are distinguished from the latter in numerous ways, but most significantly by end-products (CO_2 versus CO_2, H_2 and acetate) and enzymatic mechanisms (molybdenum-dependent versus nickel-dependent CO dehydrogenases [CODHs]).

Nickel-dependent CO oxidation almost certainly arose very early during the history of the Earth's microbiota, and could have arisen at a similar time on Mars too (4.2–3.8 billion years ago). Evolution of a molybdenum-dependent process that used nitric oxide (NO), nitrite or nitrate as electron

FEATURES

The composition of Martian brines likely differs substantially from brines on Earth

acceptors instead of molecular oxygen might have occurred subsequently, although the window for extensive microbial evolution on Mars was considerably shorter than on Earth due to dramatic decreases in temperature and water availability, and increases in radiation exposure as the Noachian period ended (3.5 billion years ago). These changes resulted in conditions hostile to life at a global scale. Several lines of evidence show that terrestrial microbes have remarkable capacities for long-term survival under extreme conditions, but could CO oxidisers of any kind have survived at local scales, adapted to extreme conditions and persisted to the present?

Although terrestrial CO oxidisers are very diverse phylogenetically and operate across a wide range of ecological conditions (e.g. pH, temperature, salinity and nutrient availability), CO-oxidising bacterial halophiles and euryarchaeal extreme halophiles in particular, represent ideal models for understanding the potential for CO to contribute to long-term microbial survival, and for exploring adaptations to surface or near-surface conditions on Mars that might be permissive for life. Since high salt concentrations are necessary for maintaining water in a liquid state at low temperatures and pressures, extreme halophiles have long been proposed as models for Mars and other extraterrestrial systems. They have also attracted interest because they have been cultured from ancient, geologically isolated salt deposits, implying that they persist on scales of 10^6 years or more.

More recent observations have revealed that the capacity for CO oxidation using molybdenum-dependent CODHs occurs in numerous euryarchaeal extreme halophiles. Isolates obtained from salt crusts, saline soils and brine pools oxidise CO at concentrations lower than those in the Earth's ambient atmosphere, which are far below levels that occur in Mars' atmosphere. This implies that CO oxidisers in surface or shallow near-surface brines on Mars could be sustained by CO uptake, perhaps analogous to observations for young terrestrial volcanic deposits and Antarctic desert soils, which derive energy for survival, in part, from atmospheric CO.

Of course, it must be emphasised that the composition of Martian brines likely differs substantially from brines on Earth. The presence in the former of magnesium and sodium perchlorates in relatively high concentrations represents a key distinction. Although perchlorates can serve as electron acceptors for dissimilatory perchlorate-reducing bacteria, perchlorate concentrations in terrestrial ecosystems are typically micromolar or less.

In contrast, brines on Mars could contain molar perchlorate concentrations in solutions with water activities or chaotropicities that are impermissible for life. Nonetheless, where water activities and chaotropicity are permissive, communities of extreme halophiles might persist in the presence of perchlorate while carrying out very slow rates of metabolism analogous to those in the terrestrial deep subsurface. In this context, it is promising that some CO-oxidising halophiles and extreme halophiles not only tolerate molar perchlorate levels, they couple perchlorate reduction to anaerobic CO oxidation. Thus, extreme halophiles could plausibly have evolved on Mars with a capacity for both CO oxidation and perchlorate reduction to chlorite or chloride. Notably, photochemical reactions in Mars' atmosphere could sustain uptake by producing CO from CO_2, resulting in a light-dependent ecosystem.

Mars has been the primary focus for studies of extraterrestrial life for multiple, obvious reasons. However, it is not the only system where CO might support microbial life. CO has been reported for both Europa and Enceladus, and could contribute to microbial metabolism in their oceans as it does in the Earth's oceans. More intriguing, however, is the possibility that CO could contribute to a microbial ecosystem in the atmosphere of Venus, which contains about 17 ppm CO, well above concentrations in the Earth's atmosphere.

Although surface temperatures on Venus are impermissible for life, habitable conditions (e.g. temperature, pressure and water availability) exist in the lower cloud layer, and have long spurred speculation about stable communities of airborne microbes. Any such communities would differ markedly from putative communities on Mars due to much warmer temperatures, greater water availability and the presence of sulfuric acid aerosols. These conditions might be incompatible with molybdenum-dependent CO oxidation as we currently know it but could support acidophilic nickel-dependent CO oxidisers. The latter group of obligate anaerobes includes thermophilic acetogens, sulfate reducers and CO disproportionators. Extremely acidophilic nickel-dependent CO oxidisers have not yet been documented, but extensive surveys for them have not yet been carried out either. It remains to be seen whether there are physiological constraints on their evolution.

Thus, while Lovelock's inferences about the relationship between atmospheric composition and life within the solar system or on exoplanets are likely true as a first approximation, Mars, Venus and other systems could still harbour microbial life that depends on trace gases. The ubiquity of CO, its relatively high concentrations in some atmospheres and the exceptional physiological and phylogenetic diversity of terrestrial CO oxidisers make it an excellent candidate for expanded research, both on Earth and as a part of planetary exploration.

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The danger in the bat: a novel tool to detect sarbecoviruses

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The current COVID-19 pandemic brings coronaviruses back on the radar after the SARS-CoV outbreak in 2002/2003, with 8096 deaths, led us to believe everything could be brought under control. Infections with different coronaviruses can lead to various symptoms and their virulence is in no way deducible from their genomes. A study by Wassenaar and Zou published in *Letters in Applied Microbiology* in February 2020 described how the non-conserved regions of coronaviruses could be used in diagnostic PCRs to detect unknown species. The authors also raised concerns about the use of bats in Traditional Chinese Medicine as a potential risk for introducing virulent coronaviruses into the human population.

Coronaviruses are classified into alphacoronaviruses, betacoronaviruses and gammacoronaviruses, with all human coronaviruses belonging to the alpha- and betacoronavirus genera, which also contain several coronaviruses of bat origin. The betacoronaviruses are further divided into five subgenera: *Embecovirus*, *Sarbecovirus*, *Merbecovirus*, *Hibecovirus* and *Nobecovirus*. Human coronaviruses like the *Embecovirus* OC43 can cause common colds, while HKU1, also an *Embecovirus*, can lead to more severe illnesses like bronchiolitis and fever. The *Merbecovirus* MERS-CoV causes a respiratory syndrome with pneumonia, fever, chills and renal impairment and has a mortality rate of 42%. The reservoirs of MERS-CoV were shown to include bats and alpacas while its transmission also involves camels. SARS-CoV and the novel SARS-CoV-2 belong to the *Sarbecovirus* subgenus together with other bat-derived coronaviruses. Both SARS-CoV and SARS-CoV-2 cause fever, headaches, breathing difficulties, chills and sometimes diarrhoea. During the outbreak in 2002/2003, which lasted for 8 months, SARS-CoV had a mortality rate of 10%. The emergence of the novel SARS-CoV-2 causing the COVID-19 pandemic, affecting people of all ages and resulting in a mortality rate between 2% and 10%, is another reminder of how diverse coronaviruses are and that better preparations for future pandemic threats are required.

Coronaviruses contain a positive-sense single strand of RNA that is 26–32 kb in size, rendering it the largest known genome for RNA viruses. Two-thirds of the genome codes for ORF1ab, which is translated into two polyproteins and processed into 16 non-structural proteins required for genome transcription and replication, in addition to structural proteins, amongst them the spike S, envelope E and nucleocapsid N proteins. Even though coronavirus RNA polymerase contains a proofreading function, leading to a stable genome, genetic recombination amongst RNA viruses is frequent. This led to the hypothesis that a novel recombinant coronavirus could emerge at any given time, while it would be challenging to predict its virulence solely from its genome.

To prepare for novel emerging coronaviruses, a study by Wassenaar and Zou aimed at identifying conserved regions within the *Sarbecovirus* genomes that would allow the design of PCR primers to detect any *Sarbecovirus*. Notably, the maximum degree of conservation within the ORF1ab over a sliding window of 60 nucleotides was 85% for different viral species belonging to the *Sarbecovirus* subgenus. When analysing the 5′ and 3′ non-coding flanking regions, the authors found that the conservation was a lot higher within the same sliding window. Moreover, the gene for the envelope protein E showed conservation of 95% within a sliding window of 60 nucleotides and the longest stretch of conserved nucleotides was 32 nucleotides long. For future pandemic threats, these regions are 'where one should target one's PCR primers to detect an unknown *Sarbecovirus*', explains Dr Trudy Wassenaar, the lead author of the study.

Although genetic variations between the *Sarbecovirus* species are extensive, the genome of SARS-CoV-2 seems to have remained relatively stable so far during the current pandemic. Different SARS-CoV-2 isolates were shown to only differ in a very few polymorphic nucleotide sites, leading to different lineages. These variations can be as few as 5 to 15 polymorphic nucleotides, out of a genome of 30,000 nucleotides, with additional single nucleotide mutations in individual isolates. This genomic stability could mean that when 'a vaccine turns out to be protective, it won't likely lose its effectiveness due to genetic drift', thinks Dr Trudy Wassenaar, as is often the case for the influenza virus vaccine.

Coronaviruses commonly have bats as their natural reservoirs and the novel SARS-CoV-2 is also thought to propagate naturally in bats, which are often used in Traditional Chinese Medicine. Hence, the authors compared the 5′ flanking region of SARS-CoV-2 with the flanking regions of coronavirus isolates from several bats from the region around Wuhan, where the first COVID-19 cases were reported. Interestingly, the coronavirus isolate to which SARS-CoV-2 showed the highest similarity was derived from the bat species *Rhinolophus sinicus*, corroborating the idea that SARS-CoV-2 uses bats as a reservoir. Bats, their body parts or faeces are commonly used in Traditional Chinese Medicine to treat different conditions by application to the human body or by oral intake. If an infected bat were used for such treatment, this is a possible explanation of how SARS-CoV-2 entered the human population and such treatment should be reconsidered. Another explanation could be that the collection of bat faeces from their natural roosting sites led to a host-jump involving the faeces collector.

Independent of the true connection between a SARS-CoV-2-infected bat and any human involved, handling bats or bat products represents a severe risk of introducing any zoonotic coronavirus into the human population. The current pandemic caused by yet another zoonotic virus raises concerns about the use of bats in Traditional Chinese Medicine and one might even suggest completely forbidding the use of bats in human treatments.

If an infected bat were used for such treatment, this is a possible explanation of how SARS-CoV-2 entered the human population

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Movie microbes under the microscope

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It may not surprise you to learn that the drama film *Contagion* has seen a huge spike on download sites amid the coronavirus pandemic, but what you may not know is that microbes have been movie stars since the earliest days of cinema. Between 1900 and 1930, moviegoers could watch bacteria and other microbes cavort on the silver screen in dozens of films with titles such as *On the Trail of the Germs* (1912) and *The New Microbe* (1912).

Cinema was an ideal technology for transforming phenomena that were invisible to the naked eye into spectacular visions. These films were popular because they invoked simultaneous reactions of attraction and repulsion in audiences.

Films of microscopic organisms, such as documentary film pioneer Charles Urban's *The Red Snow Germs* (1905) and *Typhoid Fever Germs* (1905), allowed audiences to see for themselves the previously invisible wriggling, writhing aliens that actually lived around them, on them and in them. Yet, these films were also frightening because of the role these microscopic monsters played in disease. Many fictional films featuring microbes both reflected and fuelled this anxiety with titles such as *The Dread of Microbes* (1911) and Thomas Edison's anti-tuberculosis propaganda film *The White Terror* (1915).

Food was a particularly common subject, as in *The Unclean World* (1903), *The Scientist's Lunch* (1905) and *A Bad Case* (1909). In *The Cheese Mites* (1903), the normally invisible mites from a piece of Stilton cheese were made to look like alien invaders when magnified on the screen. The film's peek into this hidden world was too revealing for some; the British cheesemakers had the film censored because they were afraid it would negatively impact the public's perceptions of their product.

By 1930, film-makers began featuring the bacteriologists who studied these killer pathogens in motion pictures. Paul de Kruif's bestselling 1926 book *The Microbe Hunters* catalogued the scientific exploits of Louis Pasteur, Paul Ehrlich, Walter Reed and other pioneering microbiologists. As the book's title suggests, these 'microbe hunters' were not feeble old men working in dusty, darkened laboratories. They were idealistic adventurers who travelled to far off locales to establish the truth about microbial dangers. de Kruif had also provided scientific advice for Sinclair Lewis' 1925 Pulitzer Prize-winning novel *Arrowsmith*, which followed the exploits of a fictional scientist who studies a plague outbreak in an exotic country and who also conducts bacteriological experiments in the backwoods of the American West.

The popularity of de Kruif's and Lewis' books made a film adaptation of *Arrowsmith* inevitable. However, the critical and financial success of 1931's *Arrowsmith* paved the way for a host of films featuring stories of courageous bacteriologists.

Arrowsmith was entirely fictional, but the film had the realistic feel of a 'bio-pic' which was also a popular genre at the time. Studios figured that if they were successful with a fictional bacteriologist, then why not make movies about real-life microbe hunters? Like *Arrowsmith*, *The Story of Louis Pasteur* (1936) was not only a commercial hit, it was also a critical triumph – winning three Academy Awards as well as being nominated for best picture. Warner Brothers Studio also tackled the story of Paul Ehrlich with the 1940's *Dr Ehrlich's Magic Bullet*. The film hit a topical sweet spot for producers Harry and Jack Warner. It was an anti-fascist medical picture featuring a Jewish scientist whose research addressed an important social problem (in this case syphilis).

Whether based on real-life scientists or entirely fictional, almost every bacteriologically based movie that followed borrowed narrative elements from *Arrowsmith*, especially those related to the theme of self-sacrifice. This led to films in which scientists travelled to disease outbreaks in exotic locations or retreated to remote wildernesses in order to conduct experiments in isolation. In *The Painted Veil* (1934), for example, a bacteriologist travels to a remote part of China to study a cholera epidemic, while *Green Light* (1937) casts the dashing Errol Flynn as a scientist who leaves the comforts of the big city to work on a cure for Rocky Mountain spotted fever in the wilds of western Montana.

Film-makers also preferred real-life scientists whose research took place in dangerous locations, such as *Yellow Jack* (1938), which focused on Walter Reed's work in Cuba. These films also often featured an ethical dilemma reminiscent of *Arrowsmith*'s moral quandary about inoculating everybody with his potential cure or maintaining his controlled study. In *The Crime of Doctor Hallet* (1938), for example, the microbiologist commits a crime in order to develop a vaccine for red fever while working in the jungles of Sumatra. Although his indiscretion is the relatively uninteresting crime of forgery, the film highlighted the lengths a microbiologist was

willing to go in order to save humanity from the menace of infectious diseases.

We might think that there was nothing objectionable about stories of heroic scientists, but these films were not exempt from censorship. Some US state censor boards, for example, excised a line of dialogue from *The Crime of Doctor Hallet*, which had implied that we should be taking our moral cues from bacteria: '*There's something to be said for bacteria. They don't waste time moralising. They eat, breed, die and kill*'.

The film facing the biggest struggle with censorship was *Dr Ehrlich's Magic Bullet*. The Production Code Administration (PCA)'s restriction on mentioning venereal disease made things difficult for Warner Brothers given that the film was about Ehrlich's discovery of Salvarsan, the first effective medical treatment for syphilis. In the end, the studio convinced censors that the final film was not about Salvarsan the drug, but about Ehrlich the man. By putting the focus on the scientist and not the science, the story became morally acceptable to the censors.

The fad for movies about heroic bacteriologists did not survive the 1940s. During the Cold War, microbiologists were no longer perceived as brave scientists attempting to cure diseases; instead the public viewed them as mercenaries betraying their scientific principles by using their knowledge to create horrific biological weapons.

This change in public attitudes was reflected in the movies and by the 1960s microbiologists had turned into movie villains. The success of the James Bond film *Dr No* in 1962 led to a flood of imitation 'superspy' films in the 1960s.

A surprising number of these films featured secret agents whose mission was to prevent the release of weaponised infectious agents, whether they were produced in the Soviet Union [*Agent for H. A. R. M.* (1966); *The Nasty Rabbit* (1965); *Project X* (1968)], by Western scientists [*The Satan Bug* (1965)] or within the lairs of 'supervillains' [*Billion Dollar Brain* (1967)].

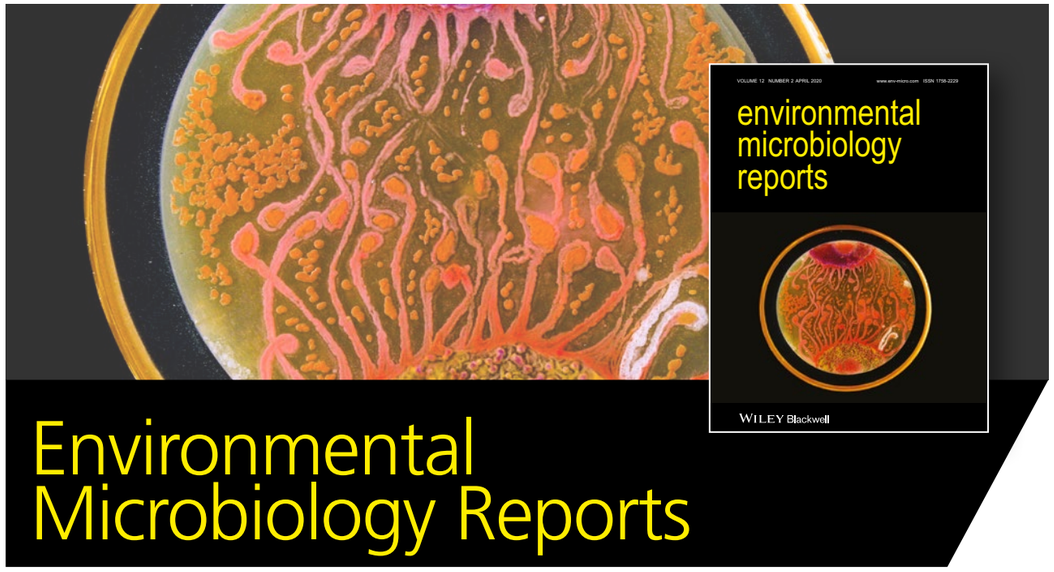
Two movies produced in the early 1970s, *The Omega Man* (1971) and *The Crazies* (1973), deviated significantly from previous bio-weapons films. The effect of these fictional infectious agents was not to cause illness or death. Instead, the weaponised pathogens in these films had a radical transformative effect on the hosts' minds and bodies. In other words, infected people turned into monsters. Monster-spawning plagues became common in horror films of the next several decades, especially when germs were combined with the theme of genetically modified organisms (GMOs) as in *Warning Sign* (1985).

By the 2000s, microbial plagues had become what radiation was in the 1950s, the go-to method for creating cinematic monsters. There have been dozens of recent films where viral or bacterial 'plagues' have broken out, creating hordes of zombies [*28 Days Later* (2002); *Dawn of the Dead* (2004); *World War Z* (2013)], vampires [*Blade* (1998); *I am Legend* (2007); *Daybreakers* (2009)] and werewolves [*Underworld* (2003)]. But these films are ultimately not about infectious diseases. In today's cinema, microorganisms predominantly serve as metaphors for a wide range of social issues such as conformity, consumerism and classism.

Sensationalised news stories about killer *E. coli* and antibiotic-resistant 'superbugs' alongside dire warnings about emerging viruses in popular books, like Laurie Garrett's *The Coming Plague* (1994), caused increased anxiety about microbes in the 1990s. In the last two decades, there have been two prominent films that have specifically addressed the serious threat posed by emerging infectious diseases. In many ways, *Outbreak* (1995) and *Contagion* (2011) recall the heroic microbiologist films of the 1930s with their plots featuring virologists saving the world from devastating pandemics. Both of these films raised awareness of emerging infectious diseases far more than any popular science book ever could.

Scientists believe that the more realistically a movie catastrophe is visualised, the more motivated the public will be to fund research in order to prevent the event from occurring in the real world. That is why many scientists willingly signed up to act as science consultants on both these films. *Outbreak*'s film-makers employed a host of leading microbiologists as advisors including pioneering HIV researcher Donald Francis. *Contagion*'s producers also utilised prominent microbiologist Ian Lipkin from Columbia University as their main science consultant, along with significant assistance from the Centers for Disease Control and Prevention (CDC) – almost every member of production sought advice from the film's scientific advisors. Because of this, the scientific elements in the film – the scientists, the laboratories, the source of the virus, the disease's epidemiology and the response of the CDC – all felt authentic.

Ultimately, the same 'attraction' and 'repulsion' that drew early cinema audiences to films of microorganisms are the same aspects that still fascinate modern audiences. The technology of cinema adds an unreality to microbes that makes them appear both beautiful and disturbing at the same time. For this reason, it is a good bet that we will continue to see microbes in our movies for years to come.



Environmental Microbiology Reports

As the world's oceans continue to be inundated by plastic waste, what impact do the smallest plastic particles have on marine bacteria?

Okshevsky M, Gautier E, Farner JM, Schreiber L, Tufenkji N. Biofilm formation by marine bacteria is impacted by concentration and surface functionalization of polystyrene nanoparticles in a species-specific manner. *Environmental Microbiology Reports* 2020; 12, 203–213

Available from

https://sfamjournals.onlinelibrary.wiley.com/doi/10.1111/1758-2229.12824

Every year, approximately 8 million tonnes of plastic waste enter the world's oceans. Plastic that enters the ocean breaks down into macro- and microplastic pieces, as well as even smaller particles in the nano-size range, which have not yet been well studied in the marine environment. To address this, scientists from McGill University and the National Research Council, Canada, investigated how the increasing presence of plastic waste in the marine environment could be affecting the behaviour of heterotrophic marine bacteria. This article addresses fundamental questions about how the increasing presence of nanoplastic in the oceans may be affecting growth and biofilm formation of marine bacteria.

The researchers show that the effect nanoplastic has on marine bacteria is dependent on nanoplastic type, concentration and the specific bacterial species. Depending on these factors, the presence of nanoplastic is able to increase or decrease the amount of biofilm formed by marine bacteria. This effect is highly dependent on nanoplastic concentration, which raises important questions about the environmentally relevant concentrations of nanoplastic in the world's oceans. Although nanoplastic is known to be present in marine environments, it is not yet possible to reliably quantify the amount of nanoplastic in complex environmental samples.

Of particular note is the observation that when the tested marine bacteria were combined to form an artificial community, exposure to nanoplastic altered the relative species composition of the biofilm formed by that community. In fact, different nanoplastics selected for unique biofilm communities in a highly reproducible manner. This suggests that the presence of nanoplastic in the world's oceans could already be having far-reaching and currently unknown consequences for marine bacterial communities.

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Environmental Microbiology

Beyond oil degradation: enzymatic potential of *Alcanivorax* to degrade natural and synthetic polyesters

Zadjelovic V, Chhun A, Quareshy M, Silvano E, Hernandez-Fernaud JR, Aguilo-Ferretjans MM *et al*. Beyond oil degradation: enzymatic potential of *Alcanivorax* to degrade natural and synthetic polyesters. *Environmental Microbiology* 2020; 22, 1356–1369

Available from

https://sfamjournals.onlinelibrary.wiley.com/doi/10.1111/1462-2920.14947

Microorganisms face constant competition in the environment. In the context of heterotrophic bacteria, these organisms have developed a diverse metabolic repertoire in order to occupy and dominate determined ecological niches. Pristine marine environments are highly oligotrophic ecosystems populated by well-established, specialised microbial communities. Nevertheless, during oil spills low-abundance hydrocarbonoclastic bacteria bloom and rapidly outcompete other marine microbiota.

The genus *Alcanivorax* is often seen as a group of heterotrophic microorganisms exclusively related to the biodegradation of hydrocarbons during oil spills. However, it is unknown how they persist in these environments during pristine conditions. In this work, we show that part of the *Alcanivorax* genus has enormous potential for biodegrading aliphatic polyesters. The ability of our *Alcanivorax* strain to degrade polyesters was driven by a unique and abundantly secreted esterase, displaying a remarkable ability to hydrolyse both natural and synthetic polyesters.

The results improve our current understanding of the ecology of *Alcanivorax* in its natural environment, where natural polyesters such as polyhydroxyalkanoates (PHAs), produced by a large fraction of the microbial community as a mechanism for carbon storage, may in fact be an accessible source of carbon and energy used by this genus in order to persist. In addition, our study also highlights the potential of *Alcanivorax* to 'clean' marine environments from polyesters of anthropogenic origin, as well as oils, via a versatile esterase. These novel findings enhance the high biotechnological potential of this genus and raise several questions for future research.

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An interview with Dr Rachael Antwis

Lecturer in Global Ecology and Conservation at the University of Salford
Lead editor of 'Microbiomes of Soils, Plants and Animals: An Integrated Approach'

Dr Rachael Antwis is a Lecturer in Global Ecology and Conservation at the University of Salford. She is the lead editor of 'Microbiomes of Soils, Plants and Animals: An Integrated Approach', published by Cambridge University Press in 2020 as part of the British Ecological Society's Ecological Reviews series. She was also awarded the Society for Applied Microbiology's New Lecturer Research Grant in 2019.

How has the New Lecturer Research Grant helped you?

During my PhD and postdoc, I had largely worked on animal microbiomes, but as a new lecturer I was keen to establish new study systems with greater potential for more applied outcomes. The funding from the Society for Applied Microbiology was instrumental in allowing me to develop a new line of research into wheat microbiomes, which I hope will continue to develop over my career.

Did you collaborate with any other organisations?

Yes, my PhD student Muhammad Afzaal and I collaborated with Dr Andrea Harper from the University of York and Dr Irene Cordero from the University of Manchester on this project.

What is a plant microbiome?

The microbial communities associated with the roots of plants are one of the most complex and interesting examples of host microbiomes on the planet. This rich 'rhizosphere' community of bacteria, fungi, protists and archaea is formed and sustained through the release of carbon-rich exudates from the plant. In turn, the root microbiome provides other nutrients to the host plant, particularly nitrogen and phosphorus, via the production of enzymes that release bioavailable forms of these vital elements. As in humans and other animals, the plant microbiome also protects the host from disease by competing with pathogens and stimulating host immune defences, as well as providing many other benefits.

Why are we interested in plant microbiomes in the context of agriculture?

Modern farming practices such as tillage and widespread agrochemical use have led to a severe reduction in the diversity and function of agricultural systems. The long-term effects of this on yield and crop security are now starting to be realised. As such, there is an urgent need to develop and test novel, sustainable methods of agriculture and food production. The soil- and plant-associated microbiome may lie at the heart of these solutions, and a deeper understanding of the ecological functions of the plant-associated microbial communities may help in the development of new farming practices with reduced ecological damage. For example, organic amendments, cover crops, greater crop diversity and reduced soil disturbance are all effective at improving soil microbial diversity, potentially reducing the need for synthetic inputs that can have considerable negative consequences for agricultural systems. Understanding the links between novel farming practices, crop yield and the microbial partners that mediate these interactions may be critical for the future health and sustainability of crop production. Modern agriculture often also relies on the use of highly selected crop strains or lines, bred for their high yield and/or resistance to disease. However, there is growing evidence that intra-cropping, that is, growing multiple strains of the same crop together, can have positive effects on yield and resilience to environmental variation, such as fluctuations in temperature and water availability. However, little work has been done to understand how the root microbiome is influenced by intra-cropping, and how this affects crop yield and other parameters of interest.

What did you do?

Through funding from the Society for Applied Microbiology, we sought to understand how intra-cropping different lines of wheat (one conventional line with three 'landrace' or older genetic lines) affected plant yield, rhizosphere bacterial communities and root enzyme profiles. In pots, we sowed the conventional line either with itself or one of the three other wheat lines. We then left the plants to grow and destructively sampled half of each treatment at the booting stage (just before the grain starts to form) and then, once the seed had ripened on the remaining plants, we harvested and weighed the grain as a measure of yield. We collected the rhizosphere soil of the destructively sampled plants at both timepoints and used fluorescence-based microplate techniques to measure the activity of six enzymes associated with the breakdown of carbon, nitrogen and phosphorus. We characterised the bacterial communities of these rhizosphere soils by sequencing the V4 region of the 16S rRNA amplicon on an Illumina MiSeq at the University of Salford.

What did you find?

We found that timepoint significantly affected enzyme activity and rhizosphere bacterial community composition, supporting the findings of similar work in other plant species. We also found a significant effect of pairing (i.e. which two plants grew in the pot) on bacterial community composition, but no effect of wheat line. This suggests that wheat lines in their own right do not necessarily support different microbial communities, but planting different genotypes together causes a shift in the community composition. Interestingly, the same pattern was also evident in the enzyme activity data; pairing had a significant effect on the activity of many of the enzymes, but wheat line did not. Together, this suggests that plants may be responding to their 'neighbours' and altering the production of exudates to recruit different microbial communities and alter enzyme profiles. Amazingly, we also found a relationship between bacterial community diversity and total yield per pot. As community richness increased, we saw an increase in the yield; however, as community evenness increased, we saw a decrease in yield. This suggests that a species-rich rhizosphere community that is weighted towards some dominant members is important for yield, but further analysis is required in order to identify these groups. We also plan to characterise the rhizosphere fungal communities using Internal transcribed spacer (ITS) rRNA sequencing to determine whether the patterns observed in the bacterial data hold true for these communities too, and how microbes across the two kingdoms interact.

How do these findings relate back to broad-scale agriculture?

The field of 'microbiome engineering' is gaining considerable interest as scientists and policymakers recognise the enormous biological potential of host-associated microbial communities. The hope is to develop sustainable approaches to food production that will have positive impacts on agricultural landscapes and associated human and environmental health, for example through improved crop yield, lower pesticide use, reduced disease susceptibility and increased genetic diversity. Intra-cropping and rhizosphere functioning may play a key role in this. For this approach to be successful, it will be critical to identify and select the most effective combinations of cultivars, based on numerous plant traits, in order to maximise the potential for intra-cropping.

Going to the end of the world – leadership development as an early career researcher

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When I found out that I had a place in a global female leadership initiative, I was both excited and puzzled. Why was I picked? What did I possibly have to offer as an early career researcher? Those thoughts are clear symptoms of imposter syndrome – it runs high in science – and most of us feel inadequate during certain situations or even most of the time.

I had applied for a place in the fourth cohort of Homeward Bound (HB) in a moment of 'if I don't try it, it's always a no' and I didn't give it any further thought when I was put on the waiting list, but a few weeks later I was offered a place.

The initiative's vision is to equip a total of 1000 women having STEMM (Science, Technology, Engineering, Mathematics and Medicine) backgrounds with leadership skills over 10 years to build a global platform of women with the ability to tackle complex issues that our society faces. The program runs over 12 months, mostly as video conference calls, homework and allocation of small working groups covering a range of different topics around communication skills, strategic planning, leadership and collaboration.

My personal circumstances had changed immensely recently; I had just become a mother and was struggling with fixed-term contracts and working part-time, worrying constantly about my productivity while fighting severe sleep deprivation. Parenthood essentially had knocked me off my path and while I was trying to get back onto it I was starting to wonder if it was even the path I wanted to be on.

What did I learn?

So basically, here I was with a place in a leadership initiative when I felt the furthest from being a leader that I could imagine. But I soon realised that this programme had come along at the perfect time for me – it gave me time to work on my career planning, to reflect on my skills and leadership qualities and connected me to a community of women to talk to. I was in the lucky position of having two previous participants based at the same university as me: Dr Katherine Duncan (HB2 participant, now HB Science faculty) and Dr Kirsty Robb (HB3 participant) who kindly mentored me.

One of the most important lessons that HB taught me was to challenge the definition of leadership. It is not this one shining star who everyone looks up to, who has it all figured out and inspires everyone they talk to, but a leader is someone who truly listens and sees the people around them, who creates an environment for everyone to thrive in and who is humble and aiming to build a lasting legacy. Leadership is present everywhere; each one of us can inspire our families and friends, just as much as our colleagues, by our actions and reactions.

The impact of Homeward Bound and future outlook

At the end of each year the cohort meets up in Ushuaia, Argentina, and the learning culminates in a 3-week sea expedition to Antarctica. Antarctica is the last wilderness on Earth, and we were completely shut off to the rest of the world. Essentially, we were in a bubble, diving into discovering our personal but also community values, discussing topics close to our hearts, changes we would like to see in the world and how we could make them a reality. We shared our struggles, shed many tears, but also experienced joy at the breathtaking scenery of Antarctica. We felt humbled by the scale and power of this land of ice and sea, and empowered by its beauty, fuelled by the fragility of this ecosystem.

A powerful personal experience as much as a shared experience, a year of being torn into pieces, but put back together stronger, determined and hopeful for the future.

I will leave this with you: everyone in science at some point has been an early career scientist, so who is to say you cannot be who you dream to be? Now is the time to take your place and make a difference. Lead the way on the topics that you care about.

I would like to thank the generous support from SfAM for partly sponsoring my participation in the programme.

Seen any good biofilms lately?*

**The title has been shamelessly borrowed from the excellent review of the same name by Professor WM Dunne Jr, Washington University*

I'm currently Professor of Pharmaceutical Microbiology at the School of Pharmacy, Queen's University Belfast where I lead the Biofilm Research Group, a multidisciplinary research group whose overarching aims are to understand how microbial biofilms tolerate antimicrobial challenges and to try to develop new strategies to control them.

That's brought me to some interesting places and has involved collaborating not just with other microbiologists, but with colleagues from a wide range of disciplines: chemists, physicists, biologists, surgeons and geologists. I didn't start out as a microbiologist however. As a child I loved natural history, and for a number of years I had wanted to be a vet. I'd obtained a place in veterinary school, but halfway through my last year in school I started to reconsider and decided I'd rather work in a lab, so I opted for a pharmacy degree. It seemed like a nice compromise between science and working with patients. That turned out to be a good decision, as I loved the scientific aspects of the degree, especially the pharmaceutical microbiology labs and classes. Queen's University Belfast School of Pharmacy always had a strong reputation for pharmaceutical microbiology research, under the direction of Professor Sean Gorman, and in biofilm microbiology, particularly related to medical device-associated infections. The late 1990s was a great time to be a student and, in particular, with the signing of the Good Friday Agreement in 1998, Belfast had an air of optimism and an energy that made it an exciting place to be. I graduated in 1999 with a pharmacy degree and spent just over a year in community pharmacy practice before returning to do my PhD in medicinal chemistry.

It was during my PhD, where I worked on synthetic inhibitors of a proteolytic enzyme involved in invasive cancers, that I also became interested in how bacterial proteases interact with their host and their potential role in the formation of biofilms. I loved working in the synthesis labs and my PhD affirmed my desire to be a lab scientist. There were a few colourful characters around and some (mainly disastrous) experiments that I doubt I'd be adventurous enough to attempt these days! I also attended my first conference in 2001, at the famous Cold Spring Harbor Laboratory, headed at that time by James Watson. I recall he showed up at the social events at the meeting, which caused a bit of a stir. My postdoctoral work focused on developing synthetic inhibitors for probing proteases involved in various bacterial processes. In 2004, I was considering taking up a postdoctoral position in Australia when I was fortunate to be offered an academic post at Queen's, where I joined the School of Pharmacy as a Lecturer in Pharmaceutical Microbiology. That marked a change of lane for me, as I was teaching microbiology and bringing my medicinal chemistry skills to a range of problems in bacterial biofilm research. I began to focus more on the microbiology and a bit less on the chemistry, but I have retained a strand of medicinal chemistry research in my laboratory.

In 2005, I spent a sabbatical in the laboratory of Professor Howard Ceri in the University of Calgary. Calgary was the birthplace of biofilm research, since it was here that Professor Bill Costerton had his lab when he published the landmark paper 'How Bacteria Stick' in 1978, coined the term 'biofilm' and made many of the discoveries and observations that defined the key concepts in the nascent biofilm field. Howard had joined the lab as a young academic, and while Bill had moved on, Howard's Biofilm Research Group in Calgary had developed a method for high-throughput screening of biofilm susceptibility to antimicrobials, which I was keen to learn. Howard and I hit it off, and he became a friend and mentor and was invaluable in helping me find my feet in microbiology research. He epitomised the qualities of a great mentor: honesty, integrity, kindness, a great attitude and an insatiable curiosity. He also told me to try to do research that is fun. I learned so much during that time.

In the past few years our group has been working on a number of research programmes, all with an overarching biofilm theme. I'm still fascinated by the role of proteases in biofilm formation, and we continue to uncover potentially interesting targets for inhibition of matrix formation. A major grant in 2007 with collaborators across Ireland established a biodiscovery programme in my lab, which has led to our recent work in antimicrobial discovery from the Kilroot salt mine, an ancient halite (rock salt) deposit and the only operating salt mine in Ireland. The 250 million-year-old halite deposit is mined for road salt, but the seams of salt at depths of up to 1200 ft underground are host to a unique and diverse microbiome, which we are investigating as a source of novel antibiotics and enzymes using both culture-dependent and genomic approaches. Finding antibiotic resistance genes among these isolated microbes has stimulated work in novel AMR mechanisms from isolated microbiomes. That work also got us interested in archaea in these complex microbiomes and their interaction with their bacterial neighbours. We also work on cold plasmas in biofilm control, and that work has been productive and great fun working with our physicist colleagues. By far the best part of my work, though, is working with a talented and motivated team, and seeing them develop as independent scientists.

As a society, SfAM has been central to my career, with so many excellent students coming through my laboratory as undergraduates funded generously through SfAM summer placement awards, many of whom have then gone on to careers in science. This scheme has been so important in helping students in undergraduate degree programmes get a real feel for microbiology research. SfAM has provided countless opportunities to broaden my horizons in microbiology, through conferences and networking events. I was also honoured to win the WH Pierce Prize in 2017. A brief encounter with Sir David Attenborough in 2018 at his SfAM fellowship award evening remains a career highlight! So, I'm excited and extremely honoured to been have elected as the incoming President of SfAM, but I take on the role with not a little trepidation, acknowledging that I have a hard act to follow in our outgoing president, Professor Mark Fielder. It's a time of great challenges for microbiologists and for learned societies more generally. However, it is a hugely exciting time of opportunity for applied microbiology, and our voice has never been more important or relevant, evident especially in these past months of the global pandemic.

Brendan Gilmore
Queen's University Belfast

London's microbiota: *The Stolen Bacillus*

Martin Adams
SfAM President 2011–2014

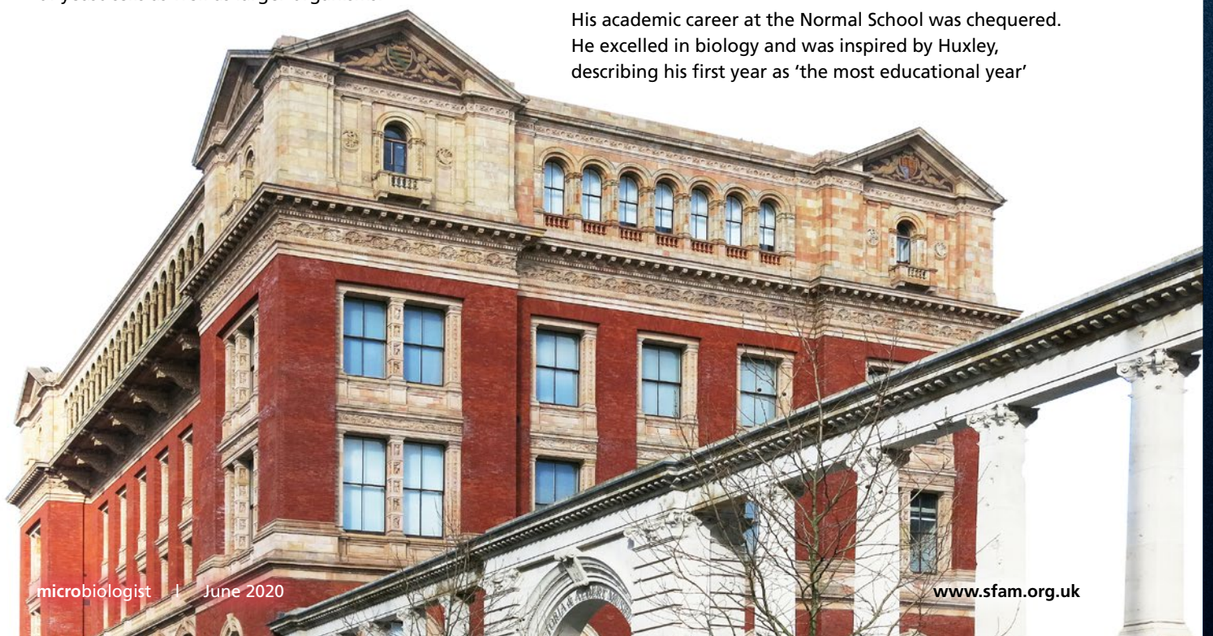
A handsome, red brick, Italianate building in Exhibition Road, South Kensington, is currently the Henry Cole wing of the Victoria and Albert Museum and a home to museum offices and archives.

When it was built in 1872 it was intended for the School of Naval Architecture but, on completion, the naval draughtsmen were banished to Greenwich and replaced by the Science Schools, later called the Normal School of Science, an amalgamation of the Royal College of Chemistry and the School of Mines. The Professor of Biology at the School was Thomas Henry Huxley, famously known as 'Darwin's bulldog' for his vigorous advocacy of the theory of evolution through natural selection. Huxley was an inspiring and innovative teacher and created modern, well-lit and equipped biology laboratories on the top floor where practical classes involved extensive use of the microscope as a tool to examine the structural features of yeast cells as well as larger organisms.

When Herbert George (H.G.) Wells enrolled in the school in 1884, Huxley was in his last year there. Wells had won a scholarship after unhappy periods as an apprentice draper and a student teacher and was destined to become a major public figure, best known today as a founding father of science fiction, author of works such as *The War of the Worlds*, *The Invisible Man* and *The Time Machine*.

Wells was born in 1866 in relatively humble circumstances in Bromley, Kent, now part of Greater London. But even then, the influence of the capital must have made itself felt since Wells writes of growing up with a cockney accent and an online article on phonetics I have seen describes his recorded voice as 'halfway to Estuary English'.

His academic career at the Normal School was chequered. He excelled in biology and was inspired by Huxley, describing his first year as 'the most educational year'



of his entire life, but his later studies in physics and geology were hindered by a combination of uninspired teaching and the twin distractions of his political activities (he was an idiosyncratic socialist) and occasional writing for magazines such as the *Science Schools Journal*. Some sense of his time at the School can be gained from the partly autobiographical *Love and Mr Lewisham* and the short story *A Slip under the Microscope*. He eventually graduated with first class honours in zoology and second class honours in geology in 1890, the year the Normal School became the Royal School of Science (it was ultimately absorbed into Imperial College).

To secure an income, Wells took a teaching post while pursuing his dream of a writing career. In 1893 he published his first book, *Textbook of Biology*. Elementary biology was required for all aspirants to the London BSc

Herbert George (H.G.) Wells enrolled in the school in 1884

and also, somewhat reassuringly, for those hoping to embark on a medical degree. It had, in his words, 'long been regarded as a difficult subject' and there were no textbooks 'that precisely covered the peculiar mental habits of the university examiners'; a sentiment sometimes echoed by students today.

He would also employ his knowledge of biology (and microbiology) in fiction. Some will remember an unnamed pathogen jumping the species barrier to bring about the demise of the Martian invaders in *The War of the Worlds*. Microbiology can also claim the crown for being the subject of the very first piece of fiction published under his name. This took the form of a short story entitled *The Stolen Bacillus*, published in the *Pall Mall Budge*t in June 1894. The story itself is rather insubstantial, but is a very early allusion to something of much more recent concern: bioterrorism. It was inspired, in part, by a wave of anarchist terrorist incidents across Europe, in particular a bomb attack on the French Chamber of Deputies in Paris in 1893 by Ravechol Vaillant, who is mentioned in the text. A bacteriologist is showing slides and cultures to a visitor who takes a particular morbid interest in their pathogenicity. Prompted by his questioning the bacteriologist shows the visitor what he claims is a viable culture of *V. cholerae*: 'mysterious untraceable death, death swift and terrible, death full of pain and indignity' as his visitor lugubriously observes. After the visitor has left, the bacteriologist discovers the culture is missing and rushes out in pursuit. His wife sees him leave precipitately without his hat, an affront to Victorian decency, and is compelled to follow. There ensues a hectic three cab chase across London.

With his pursuers closing in, the anarchist alights near Waterloo Bridge but in the process breaks the culture tube. Unable to fulfil his original aim of infecting the water supplies, he drinks what remains in the broken vial. Confronted by the bacteriologist, still hatless and wearing a velveteen jacket and one carpet slipper (a look still favoured among some senior microbiologists today), he declares '*Vive l'Anarchie*! You are too late, my friend. I have drunk it. The cholera is abroad!' With that he waves a dramatic farewell and strides off towards the bridge carefully jostling as many people as he can, with a view to spreading the infection. The bacteriologist's wife, Minnie, the only character in the story given a name, then arrives bearing shoes, overcoat and a hat for her husband. Restored to decency, the bacteriologist confesses that his visitor's interest had stroked his vanity and that since he did not have a culture of *V. cholerae* to show, he had substituted one of bacteria thought to be responsible for the blue colouration of certain monkeys. There, rather limply, the story ends. What happened next is left for the reader to imagine – perhaps the anarchist in his dingy lodgings, anxiously performing contortions before the mirror, monitoring the progress of unwanted Prussian Blue patches and aquamarine eruptions.

Things not to do on Twitter

Twitter is a fantastic communications platform for scientists. Not only are there a lot of researchers engaging through Tweets, but conversations are broad, ranging from sharing new research to promoting advocacy for under-represented voices in academia. There are lots of ways to use Twitter effectively as a scientist but there are also some pitfalls that can make your experience on the platform distinctly underwhelming or downright negative. Here are some of my suggestions of what to avoid to help get the most out of Twitter.

Don't be unprofessional

If you're using Twitter as a researcher then you are using it in your professional capacity so make sure you keep the tone and messaging of your Tweets professional.

Most people misinterpret professional to mean severely restrictive messaging stripped bare of any opinion, personality or humour. This isn't the case at all and the best way to think of being professional is would you say this at work? The acid test for me when working out if my messaging is professional enough is that I imagine walking up to someone I don't know at a conference coffee break and talking to them. Anything that would be appropriate to say in this instance makes it into my Twitter feed, anything that I wouldn't say doesn't. Does that mean I wouldn't crack a joke? Of course not. Does it mean I wouldn't share an opinion? No; on the contrary, it would be weird if I just recounted facts about the session that we had both just seen without giving my own perspective.

Don't be afraid to show your personality

As a follow-on from the previous point, it's good to show your personality on Twitter.

It makes what you say more interesting and gives it context and novelty. Writing about research or events as if it were a paper abstract will make it sound dry and boring. Likewise, if you don't talk about any of your interests on Twitter, then you're missing an opportunity to connect with people in your field who like similar things and want to learn more about you. Injecting your personality is a way to build meaningful relationships on Twitter that can become research collaborations or friendships in the future. If you like baking, have pets or play a sport, mention it every now and again.

Ben Libberton
Science Communicator at Aurora Dynamics

Don't give 'em everything

While it is good to show your personality, there might be things that you want to hold back.

There can be lots of reasons for this; most likely there are things in life that we just want to keep private, and that's totally OK. There's also a practicality to creating a slightly more curated version of ourselves online, i.e. it's easier to be memorable if we constantly talk about a defined set of topics. For example, on Twitter I might identify as the microbial ecologist who lives in Stockholm and likes baking and playing football. I can then limit my Twitter feed to discussing microbiology, Sweden, baking and football, which will give a hint to my interests without being too diffuse.

Don't look for fame

Like with any social media platform it's easy to see success as having a large following.

Being a Twitter celebrity is rare in academic circles and is not a good way for measuring how well the platform is working for you. I prefer to look for meaningful interactions with people as the barometer for success. My ultimate goal for Twitter is to take interactions from the platform offline so that I can meet or chat to people that I meet and develop deeper connections and more meaningful collaborations. To that end, it is good if my follower count gradually increases but I don't need to be a Twitter celebrity. To properly judge success it is better to look for who is following you and see if you can engage with them in a meaningful way.

Don't be mean

Do I really have to explain this?

Twitter is full of trolls and anonymous keyboard warriors who may target you or your friends at some point in time. Don't be one of them. Remember that there are real people with real lives, thoughts and feelings behind the Twitter accounts. In the heat of the moment, it is easy to get angry and take it out on your keyboard. Just remember that Twitter is public and there could be a record of what you said, even if you delete your Tweet, but most importantly, people can get hurt.

Don't hide

By the same token, don't hide either. Reply to Tweets that you have an opinion on or from people who you respect.

Respectfully inject your perspective or opinion wherever you can. This can help you avoid falling into the trap of repeating what everyone else is already saying. Liking and retweeting other people is a fantastic way to engage and highlight what others are saying, but try not to stop there. Try to Tweet as many original thoughts as you can, as well as replying to people in a thoughtful way.

Don't take things personally

By the same token, if you are on the sharp end of some criticism or some trolling don't let it get to you.

For me, it helps to empathise with the trolls by thinking how bad could their situation be if they choose to take time out of their day to lash out at me online? There are also tools available on Twitter to block or report accounts that you don't want to hear from or see what you are posting. Use this feature liberally and don't give the trolls the time of day. If it really does bother you, don't let it eat away – talk to someone about it. If you need to take a break and stop using Twitter for a while, go ahead, delete the app from your phone and log out from your computer.

Don't delay

Now is the perfect time to engage more on Twitter and build connections and collaborations for the future.

Maybe your next boss is recruiting there now; maybe your next collaborator is looking for help and maybe your next student is looking for a project. Jump in, be professional, be yourself and look for people who you can really connect with.

Exploring space from prison

Charles S Cockell
UK Centre for Astrobiology, University of Edinburgh

Space was once a frontier only for governments. At the beginning of the space age in the 1950s, the Soviets and Americans held the keys to this promising new environment, a place that would eventually give rise to Earth observation satellites, new insights into our neighbour, the Moon, and stunning panoramas and science returned from Mars, Jupiter's moons and worlds further afield.

With an ever-expanding circle of actors now in space, including more governments and private companies, the opportunity to contribute to this future has also been enriched. One part of this future is human exploration.

It always occurred to me that in many ways prisons are not dissimilar to future planetary stations, where the incarcerated have experience of confinement and the social conditions of isolation. I began an initiative, *Life Beyond*, with the Scottish Prison Service (SPS), to give prisoners the opportunity to contribute to plans for the human future beyond the Earth.

Following a successful pilot scheme in Scottish prisons in 2016, it was possible to design a 4-week course that would give prisoners the opportunity to imagine how people might explore and settle on other planets. In the first week, the prisoners learn about the place where they will build their station, such as the Moon or Mars. In this week, we also provide a prison library with a set of books about space exploration and ideas for planetary stations, which they can keep after the course. In the second week, armed with this new-found knowledge, the participants then consider how to build a station. How will they get oxygen, food and water? The learning sessions are steered by us at the University of Edinburgh, but the participants very much take the lead in designing their own stations and involvement in the course is voluntary. We usually have between 15 and 20 people take part. One of the thrilling aspects of this stage of the course is that participants can explore the full reach of their interests. The scientists and engineers among them can get into the detail of the station. The artists can paint and draw the base (Figures 1 and 2), and our initiative has led to many new tunes from the musically inclined, including Martian blues music and lunar songs.

In the middle of the course there is a break of a few weeks, allowing the participants to get to work designing their station and pulling together their plans. In the third week of the course, each participant has to produce an artefact of exploration. This could be a diary entry, a poster to entice tourists or a historic timeline of the station. We have run creative writing contests where the participants write their first email home, having been deployed to their stations.

In the final week of the course, we consider the management of the station. How will it be run? Will it be democratic? How must people order themselves in a confined environment to be successful? In this last segment, the participants can use their own experiences in prison to consider how distant groups of humans might be organised.

EDUCATION AND PUBLIC OUTREACH

The unknown future of humans beyond the Earth means that the field is wide open to the creative mind and this lends space exploration and settlement to the prison environment as a vehicle to encourage a whole range of learning. Science, technology, writing skills, poetry, music and civic responsibilities have all come into the purview of the course.

At the end of this activity, we are keen to ensure that there is a tangible product. Although the learning experience

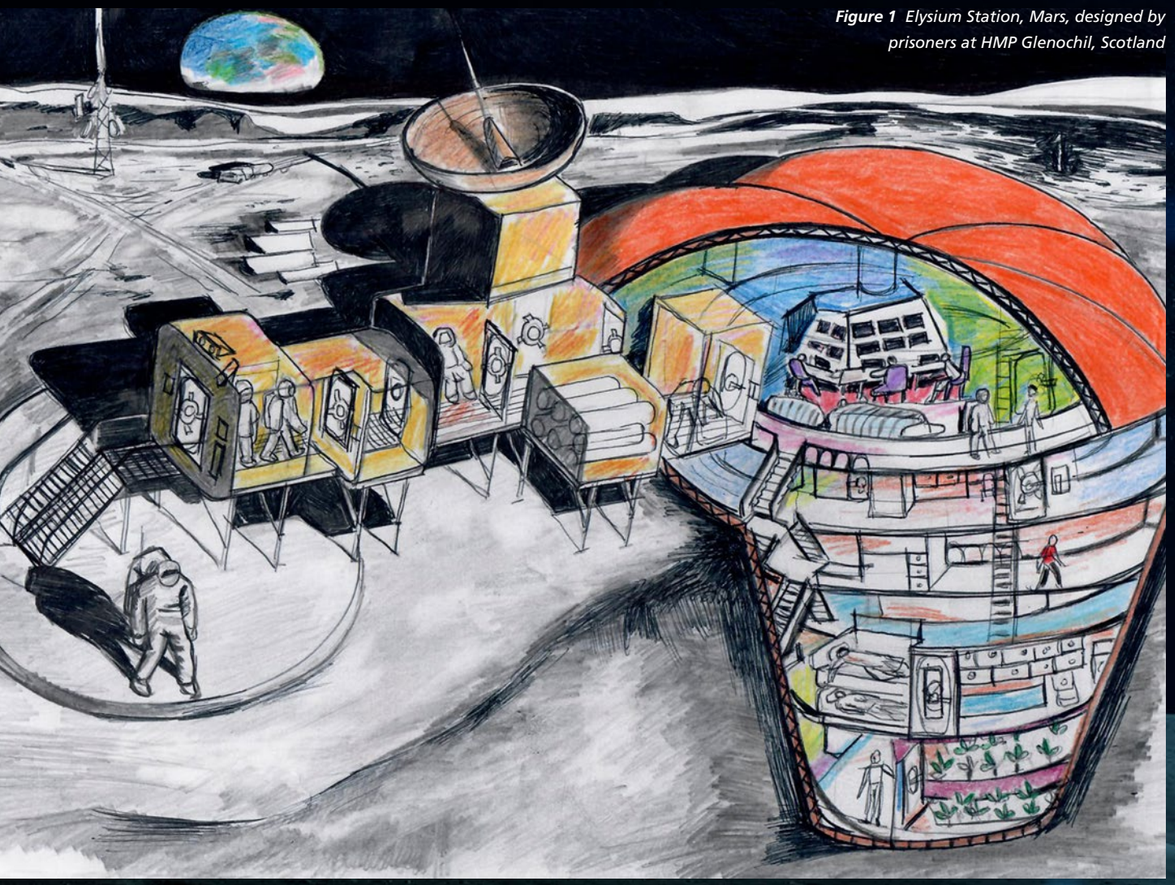


Figure 1 *Elysium Station, Mars, designed by prisoners at HMP Glenochil, Scotland*

is, hopefully, in itself engaging for the participants, it helps when the whole programme has a direction and purpose. One of the endpoints is to publish a book. With light-touch editorship from our team at the University of Edinburgh, *Life Beyond* has so far resulted in two published books that we have produced in conjunction with the British Interplanetary Society. *Life Beyond – from Prison to Mars* and its follow-up book *From Prison to the Moon*, contain the station designs, artwork and writing from their efforts, with any proceeds going to space education projects. We distribute these books to space organisations and agencies, providing the participants with a real sense of making a solid contribution. One copy of the book was signed off by astronauts at the European Astronaut Centre (EAC) and sent back to the participants.

Those who find themselves incarcerated sometimes have negative views of education and we have found that this exercise – to go from no (or little) knowledge of a subject to producing a book has a profoundly positive effect on the participants' views of education.

Figure 2 *A concept for a Moon base designed by prisoners at HMP Glenochil, Scotland*

As the course has advanced, we have been able to expand on the depth of the educational experience. Those who took part in previous iterations have engaged in peer-to-peer teaching. Two participants developed a workbook that can be filled in by participants during the course to contribute to their Personal Development Awards, which include 'Self in Community' and 'Self and Work', thus

FURTHER READING

Cockell CS. *Life Beyond – from Prison to Mars*. London: British Interplanetary Society, 2018

Cockell CS, Fosado YAG, Hitchen J, Landenmark H, Perera L, Vissers T. Life Beyond – a program to use astrobiology to teach science and advance space exploration through prisons. *Journal of Correctional Education* 2018; 69, 30–43

Cockell CS. Life Beyond – planning for Mars in prisons. *Astronomy and Geophysics* 2018; 59, 4.32–4.35

integrating the activity into more formal education goals in prison. We are currently writing additional workbooks for teachers with resources, information on other planetary bodies and slides, which will allow anyone teaching in prisons to set up such a course themselves without needing prior knowledge of space exploration. The existing books that we have published can also provide a resource to build upon.

We don't know when humans will eventually build permanent stations on the Moon or Mars. However, regardless of when it happens, it offers a tremendously exciting vision of human society and its potential. In that sense, engaging people in imagining this future is an extraordinarily powerful way of involving anyone in shaping ideas about society. Nowhere is this truer than in prisons. *The Life Beyond* project demonstrates that from behind the confines of a prison you can direct humanity to the stars.

Those who find themselves incarcerated sometimes have negative views of education

Thought you couldn't recycle single-use lab plastics? Think again…

Lisa MicMillan and **Jo Brown**
School of Applied Sciences, Edinburgh Napier University

Like many institutions, Edinburgh Napier University is committed to reducing its environmental impact and we have implemented initiatives to improve sustainability and reduce our waste. One area that has always provided a challenge in terms of waste is our laboratories, hosted in our School of Applied Sciences. Laboratory waste is considerable – more than 5 million tonnes are thought to be generated each year.

Within the School of Applied Sciences, our laboratories in microbiology, biomedical science and biological chemistry produce hundreds of kilograms of single-use plastic waste and we were dismayed at the amount of plastic waste that was collected by our waste contractor and sent to landfill. We initiated discussions with our contractor and were surprised to hear that the option to recycle lab plastics does not appear to have been considered by many; issues surrounding biological and chemical contamination have been viewed as too challenging. However, following further discussions our waste contractor confirmed that they would be able to accept lab plastics as part of its Dry Mixed Recycling collection, which was already established at the university. This meant that lab plastics would be handled alongside waste from areas such as office and canteen spaces. Of course this meant the establishment of protocols for the decontamination of plastics to render them safe for the recycling stream.

This included:

- decontamination protocols using high-level disinfectant had to be standardised across the various labs
- working with various lab users, signage was developed to clarify the necessary decontamination, rinsing and drying stages.

Since we established this scheme in the summer of 2019, we have diverted more than 700 kg of single-use plastic waste from landfill. Other projects we are developing include plastic glove recycling, focusing on ethical suppliers whose interest goes beyond the point of sale, and hosting sustainability-focused workshops for technicians and lab users from other institutions.

We recently witnessed the huge appetite for change whilst presenting our work at a HEaTED Regional Network Event for technicians at Queen's University Belfast. We were overwhelmed by the interest shown by technicians from across the region, where one thanked us for 'taking the time to come and inspire us'.

Even in the last week, we have been considering whether chemical decontamination is necessarily the best option: could autoclaving prior to recycling actually be more environmentally friendly? We need to evaluate the options. Whilst lab plastic recycling is a big step forward it is only the beginning of the journey towards making our labs more environmentally sustainable.

Finally, if you ever wondered what to do with empty steel solvent drums, look no further than the example used by the new Gardening Club here at Edinburgh Napier University.

We are happy to discuss our work in this area; please contact us for further information!

How science is informing government policy more than ever right now

During what many have referred to as 'unprecedented times', scientists have duly taken the lead in helping countries navigate the unknowns of COVID-19. Many UK citizens can now identify Chris Whitty, the government's Chief Medical Officer, and Sir Patrick Vallance, the government's Chief Scientific Adviser, as quickly as they can name prominent politicians as a result of both advisers regularly participating in daily press conferences from 10 Downing Street.

Polls conducted in March and April have also found a decrease in the number of people who would refuse to have a coronavirus vaccination, indicating public education on the importance of vaccinations is resonating.

Most importantly, science has played a significant role in informing and shaping government and policy. For example, the Scientific Advisory Group for Emergencies (SAGE) has been providing essential advice to ministers, ensuring that government decisions are based on credible and frank scientific evidence. Likewise, the government recently launched a Vaccine Taskforce to ensure research and industry bodies are provided the resources and support they need to develop a vaccine. Amongst the government's COVID-19 related consultations, the Science and Technology Committees have opened inquiries to begin collating lessons learned from the science community to help governments better prepare for future outbreaks. The government's decision to be transparent and publish its evolving evidence, in line with publishing companies including SfAM's journals, is a testament to the collaborative approach it's pursuing.

While these developments are welcome, one of the biggest questions for the scientific community is what will the future of science policy be once the epidemic subsides. Shortly before the UK went into lockdown, the Chancellor pledged to increase public R&D investment to £22 billion per year by 2024–25. Similarly, the UK government, at the time of writing, has been the biggest contributor to the international Coalition for Epidemic Preparedness Innovations (CEPI) to help find a vaccine. Both developments indicate the current government is committed to supporting scientific research and development.

However, the true test of the government's commitment will be how the government chooses to balance public health versus economic health as mounting economic pressures may compel governments to prematurely ease lockdowns. As the seismologist Lucy Jones adequately sums up the critical relationship between science and government, "natural hazards are inevitable; the disaster is not."

Lisa Rivera
Policy and Public Affairs Manager

POLICY AND PUBLIC AFFAIRS

The government's decision to be transparent and publish its evolving evidence, in line with publishing companies including SfAM's journals, is a testament to the collaborative approach it's pursuing

SfAM Mental Health Champions

Lucy Harper

Lucky Cullen

Nasmille Larke-Mejía

There are plenty of different types of support out there, and a Mental Health First Aid Champion can help you access them. Mental Health First Aid Champions are a point of contact if you, or someone you are concerned about, are experiencing a mental health issue or emotional distress.

They are not therapists or psychiatrists, but they can give you initial support and signpost you to appropriate help if required.

MHFA Champion
MHFA England

SfAM Mental Health First Aid Champions can:

- understand why mental health is as important as physical health
- help build a mentally healthy workplace and understand how Mental Health First Aid fits into the workplace
- recognise the main symptoms of mental health conditions
- listen non-judgmentally
- use ALGEE to provide Mental Health First Aid for the most common mental health conditions
- guide a person towards appropriate professional support.

WEEKLY WELL-BEING CHECK-UP

#ADDRESS YOUR STRESS

Try using this list each week to check in with your mental health

Where's my mental health today?

How do I feel today?

Mentally?

Physically?

Looking after my well-being

Am I drinking enough water and eating a balanced diet?

How did I sleep last night?

Did I feel rested when I woke up?

Is there anything I can improve?

How's my thinking today?

How are my thoughts making me feel?

Am I having unhelpful thoughts?

For free resources on spotting and challenging unhelpful thoughts, visit **getselfhelp.co.uk** or create Your Mind Plan with **Every Mind Matters**

My stress container

How full is my container?

Am I using helpful coping strategies?

Are they working?

Learn about your stress container here: **mhfaengland.org/mhfa-centre/resources**

Lisa Rivera
Policy and Public Affairs Manager

We all use unhelpful coping strategies sometimes, but as with any skill we can learn new, helpful coping strategies.

Here's some **self-care tips** to help **protect against stress**:

#ADDRESS YOUR STRESS

Try

Get moving! Physical and mental health are connected – so eat well and exercise to release endorphins. Find a fun activity that suits you and your schedule.

Setting aside time to have fun or indulge yourself – positive emotions can help build a buffer against stress.

Learning a new skill – whether painting, playing guitar or a new language.

Sharing how you're feeling – it's OK to ask for help and support.

Switching off from distractions make time for yourself as a regular part of your routine. Schedule a reminder if you need to.

ON
OFF

Avoid

Overdoing it on sugar, caffeine or alcohol – they're a quick fix which can increase stress in the long term.

Overworking and checking your emails out of hours – we all need time to unwind.

SWITCH OFF

Spending **too much of your free time** in front of a screen – phone included. Don't feel pressured to always be 'doing' something.

Chasing perfection – it can create unrealistic expectations. Accept that mistakes will happen.

Bottling up your feelings and assuming they will go away – this can make things worse in the long run.

ANXIETY
FEAR
ANGER

What is ALGEE

Approach the person, assess and assist with any crisis
Listen and communicate non-judgmentally
Give and support information
Encourage the person to get appropiate professional help
Encourage other supports

A
E L
E G

ALGEE is a life-saving acronym used in Mental Health First Aid, to help people understand the process of dealing with a person struggling with their mental health. Just like the ABCs of CPR in First Aid, remember ALGEE with Mental Health First Aid – they can both save lives!

As the majority of us have now moved to remote working, human connection has never been so important. Remote working can increase feelings of loneliness and isolation, which are risk factors for mental ill-health. Now as ever, we urge you to be kind to yourselves, keep practising your self-care and prioritise your own well-being.

Bringing together biologists in tackling coronavirus

It seems a lifetime ago when we were celebrating our 10th anniversary at the Science Museum back in early March. In an evening of celebration, we presented Sir David Attenborough Hon FRSB with the inaugural RSB Lifetime achievement award, and he delivered a rousing speech to a room full of scientists, researchers, policymakers and sector leaders. We were delighted that SfAM was a sponsor and to see the 'Wild Types' table representing your sector.

Somewhat prophetically, Sir David stressed the need for politicians and biologists to work together in the face of adversity; words that now seem particularly poignant in today's climate.

He told the audience: "We live in a democratic society, so we can vote for the politicians who we think are going to help with the crises that we all face."

"It is unthinkable that biology was once regarded as something not of particular great importance, and it's unthinkable that people could be put into power without an understanding of the way the world works. [It is] that understanding which you [biologists] are responsible for inculcating the population of this country."

The COVID-19 pandemic has brought the stark reality of fundamental epidemiological principles straight into the lives of millions worldwide, making such an understanding more crucial than ever.

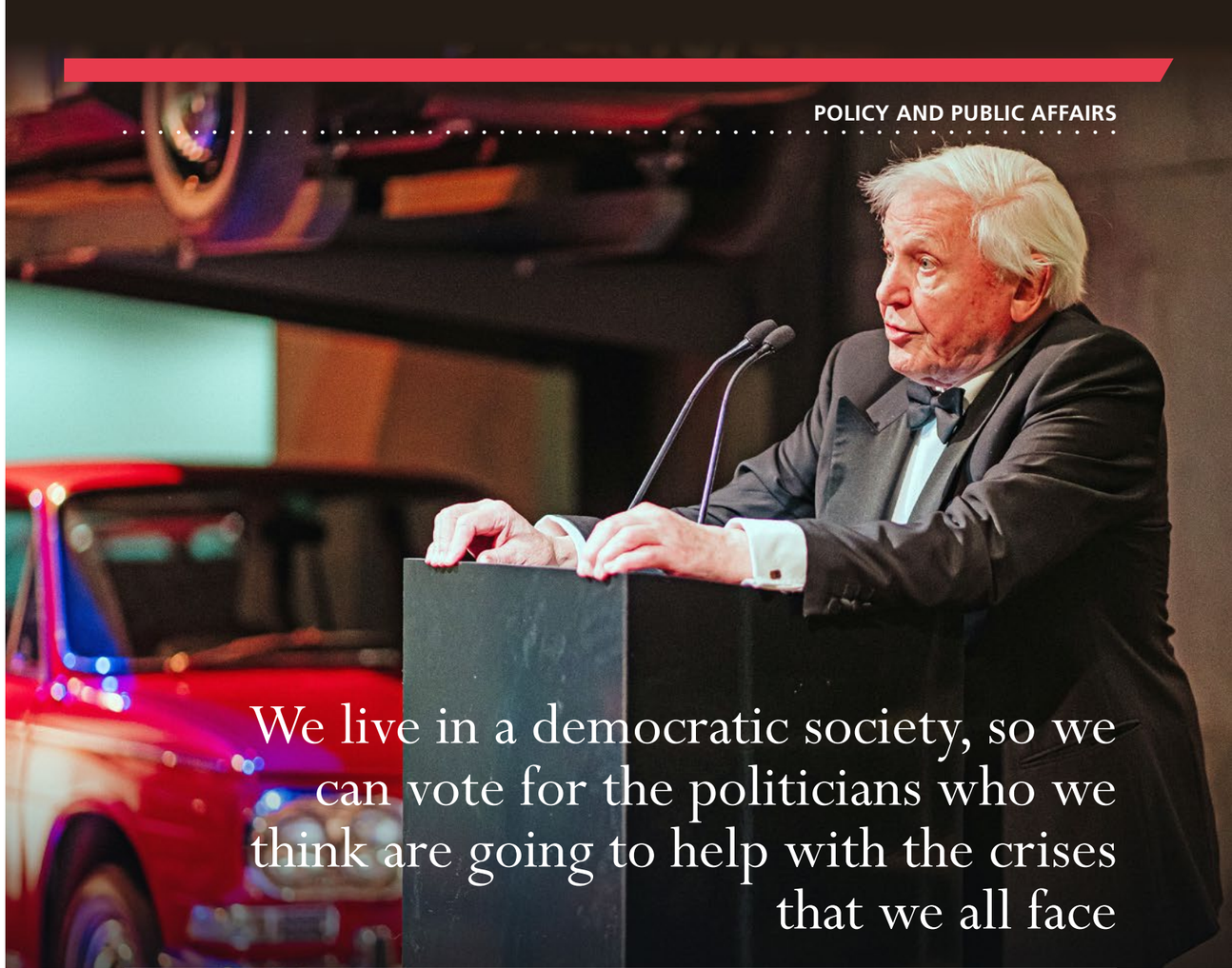
The government's daily briefings regularly stressed the importance of science and data in their decision-making, and scientific terms became part of every household's daily vocabulary – we were (and still are) living, day by day, in a scenario driven by bioscience principles that were once confined to textbooks and journals.

Every decision made across Whitehall and beyond has relied on input and guidance from epidemiologists, virologists, social scientists and more; multitudes of bioscientists have become honed science communicators as they translate their expertise into policy and legislation.

Alongside shaping policy, biologists were mobilising across the country and the nation has started to see the incredible importance of microbiology and its application to daily life.

The role of the RSB is a small but essential one in all of this – we are working with our members and member organisations to continue to mobilise the bioscience community, keep biologists informed and help where possible.

Mark Downs CSci FRSB
Chief Executive of the Royal Society of Biology



We live in a democratic society, so we can vote for the politicians who we think are going to help with the crises that we all face

We published our first COVID-19 email bulletin in March, and since then we've continued to keep thousands informed and up to date with news and the latest research. Although our events are suspended for the safety of everyone, we are working on new online formats to keep the conversations going, even if we can't leave our homes.

We're using our platforms to help signpost a number of resources, including help for parents tasked with education delivery, ways in which people can help with the pandemic response, and resources published by our membership organisations and other bioscience organisations.

Our membership magazine, *The Biologist*, has also published a series of interviews with key researchers involved in the COVID-19 response, and we are using our communication channels and networks to help amplify any requests for help across the sector.

We have made our Intermediate Biology Olympiad school competition free for pupils worldwide, so they can easily take part at home, and we'll be releasing more online outreach and engagement tools to help inspire pupils outside of the classroom.

Amongst everything else, we are also continuing with business as usual. Our Policy Resource Library was launched in April, with more than 800 policy documents, reports and publications in an easily accessible free online format. The Library is the perfect starting point for anyone and everyone looking to understand more about how science and policy intersect – an understanding that is no doubt more crucial than ever before.

Our Nancy Rothwell drawing competition, photography competition and awards are still ongoing, and our committees and working groups continue to meet, albeit digitally. For more information on how the RSB is operating during the outbreak, please visit the rsb.org.uk website.

I can only offer sincere thanks and gratitude, on behalf of the RSB, to all of the bioscientists out there working tirelessly to help manage this outbreak, from those relentlessly working in the labs through to those who have returned to the frontline to help with the NHS. We can only look forward and ensure that, as life returns to normal, we take with us into the future the lessons learned, the skills we have strengthened and the resilience we have nurtured.

The latest news, views and microbiological developments

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The new and improved Whitley WASP Touch

Don Whitley Scientific has recently launched the new and improved Whitley WASP Touch spiral plater. WASP Touch allows bacterial and fungal colonies to be enumerated over a 100,000-fold (5 $\log_{10}$) range on a single petri dish, from a minimum of 20 cfu/ml in 1000 µl pour plate mode to a maximum of 2 x 10^6 cfu/ml in 10 µl logarithmic mode.

The latest version of the product features connectors for sanitising fluids and waste on one side of the product and electrical connectors on the other side. Placing all connectors on the sides of the product means they can be more conveniently accessed by users. The connectors are also recessed to protect them from being knocked inadvertently.

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SfAM Annual General Meeting agenda

89th Annual General Meeting of the Society for Applied Microbiology

16 July 2020, virtual meeting at 11:00–13:00

1. **Apologies for absence.**
2. **Approval of minutes of the 88th Annual General Meeting held in Glasgow, July 2019; published in the September 2019 issue of *Microbiologist*.**
3. **Matters arising from the previous minutes.**
4. **Report of the Trustees of the Society 2019:**
   (i) Objectives and Activities.
   (ii) Achievements and Performance.
   (iii) Financial Review.
   (iv) Plans for the Future.
5. **Adoption of the 2019 Annual Report.**
6. **New members, deaths and resignations.**
7. **Nomination and election of new Trustees.**
   (i) Executive Committee members.
   (ii) President.
8. **Special resolution to alter the Articles of Association:**

   That the draft Articles of Association produced to the meeting, and for the purposes of identification, initialled by the Company Secretary, be adopted as the Articles of Association of the Charity in substitution for, and to the exclusion of, the existing Articles of Association.
9. **SfAM Rules (to accompany the Articles of Association), to note.**
10. **Any other business*.**

Explanatory note to accompany Agenda item no 8, the special resolution to alter the Articles of Association

At the 2019 AGM, Members voted to accept a set of amendments to the Articles of Association. These included various clarifications, updating language to make it simpler or to reflect culture changes, and embedding any relaxations or clarifications in the law since the last Articles were written.

The Trustees' proposals this year are much less substantial.

First, as part of our commitment to transparency, we have commissioned design work to make the Articles easier to read. This has resulted in proof-reading suggestions to address minor inconsistencies such as capitalisations and hyphens. We seek Members' agreement to make these changes. The amended Articles, as clean and marked-up copies, are available here **https://bit.ly/2TNzBbw**.

Second, we noted that Paragraph 2 of Article 10.9.1, referring to the President's term of office, was incorrect. The SfAM President's term of office has always been three years, and so the date on which the Articles state that the term ends should say "the President shall hold office until the *third* AGM after the date on which he/she takes office as President" not "the *second* AGM". We seek Members' agreement to make this change, which is included in the amended Articles referred to in the previous paragraph.

** To ensure the meeting keeps to time, items of any other business must be raised with the General Secretary at least 24 hours before the start of the meeting.*

FOR MORE DETAILS AND REGISTRATION SEE OUR WEBSITE
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