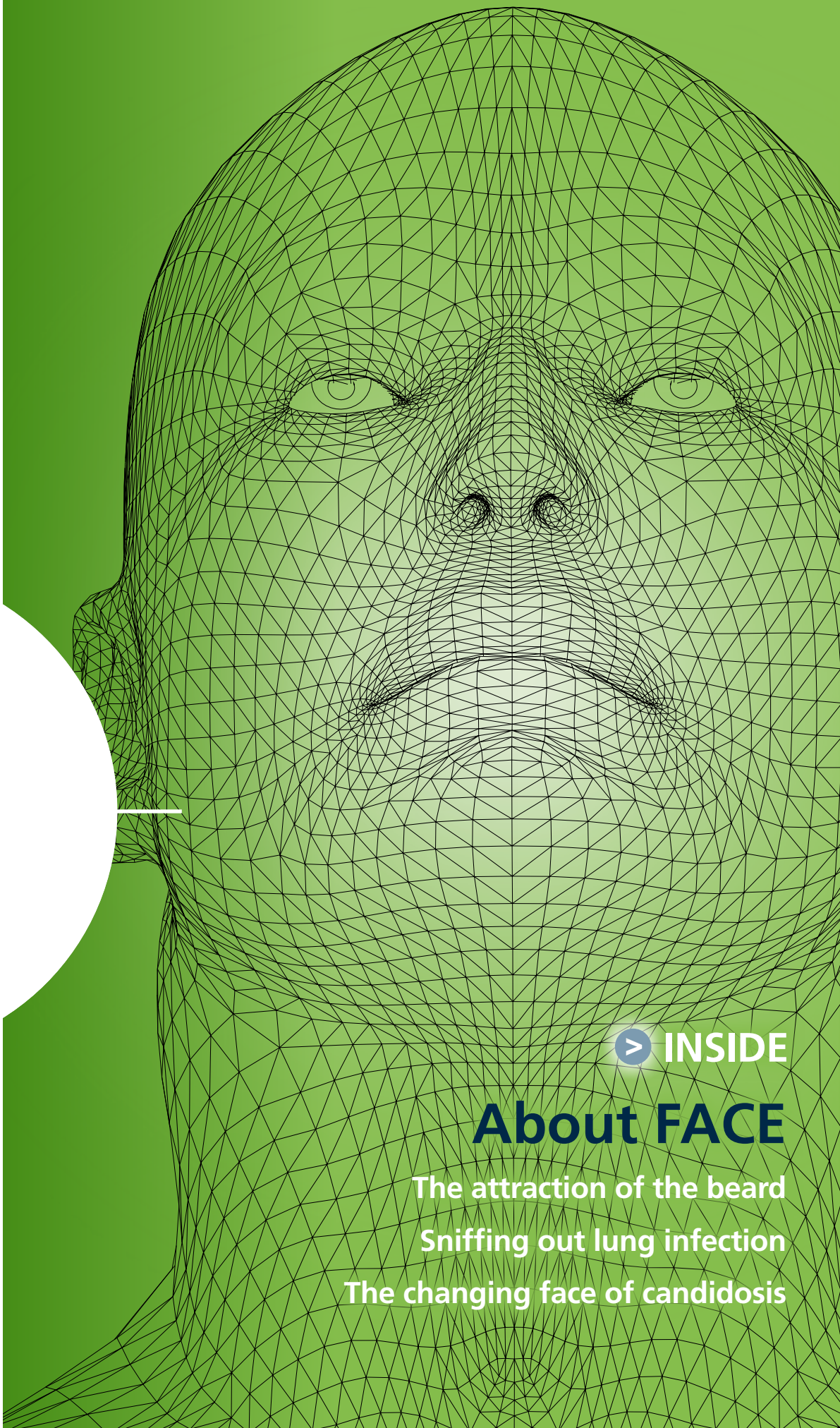
microbiologist

The magazine of the
Society for Applied Microbiology



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Paul Sainsbury reviews the content of this issue

microbiologist

Everybody picks their nose. It's what you do with the contents that defines you.

When I was younger my fingers were permanently up my nose. I certainly don't have my digits up there now to the same extent, but I would be lying if I said I never had a forage now and again.

Most people would agree that picking your nose is frowned upon. But picking it and eating the contents is, well… gross. However, the habit is extremely common, especially by children (and adults stuck in traffic on motorways) – but generally speaking, most of us grow out of it during our teenage years – or just do it on the sly.

However, a recent study in Applied and Environmental Microbiology suggests that our bogies contain salivary mucins that form a barrier against cavity-causing bacteria and that we should in fact be happily eating them – and certainly not discouraging our kids from doing the same. The paper also presents evidence to suggest the mucus could defend against respiratory infection, stomach ulcers and HIV… or alternatively you could use a tissue.

This issue of *Microbiologist* looks in detail at some of the fabulous flora that live in or around the human head. A really good read this issue is Stephen Mortlock's insight into syphilis. The article delves into some of the mystery and legend surrounding the disease as well as the consequences the tertiary phase has on the face.

Another teatime read is from Deborah Lockhart, a mycologist from the University of Aberdeen. Observed cases of oral candidosis saw a prolific rise during the 1980s amongst young men who it later transpired were HIV positive. As infections of this type reveal a lot about the immune system of the host it is important that research continues. We also have a limited arsenal of antifungals and Deborah looks at the current situation with the rise of resistance among candida strains and how this may affect future treatment.

In London's Microbiota, Martin Adams talks about gin. I think that's enough said about that to make you skip straight to that article on pg 36.

There are also articles on noses, eyes and ears too and a couple of grim pictures especially for you, because let's **face** it, we are microbiologists and we love an icky picture or two.

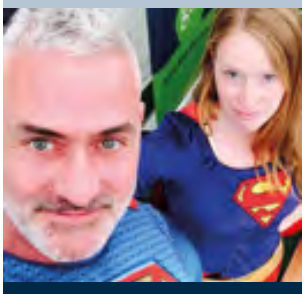
Next year we hope to bring you an issue devoted solely to the Microbiology of S*f*AM. We hope that issue will give you an insight into some of the work we fund, the work our various committees perform and some more background into the Members and staff that make up the Society for Applied Microbiology.

NEWS IN BRIEF

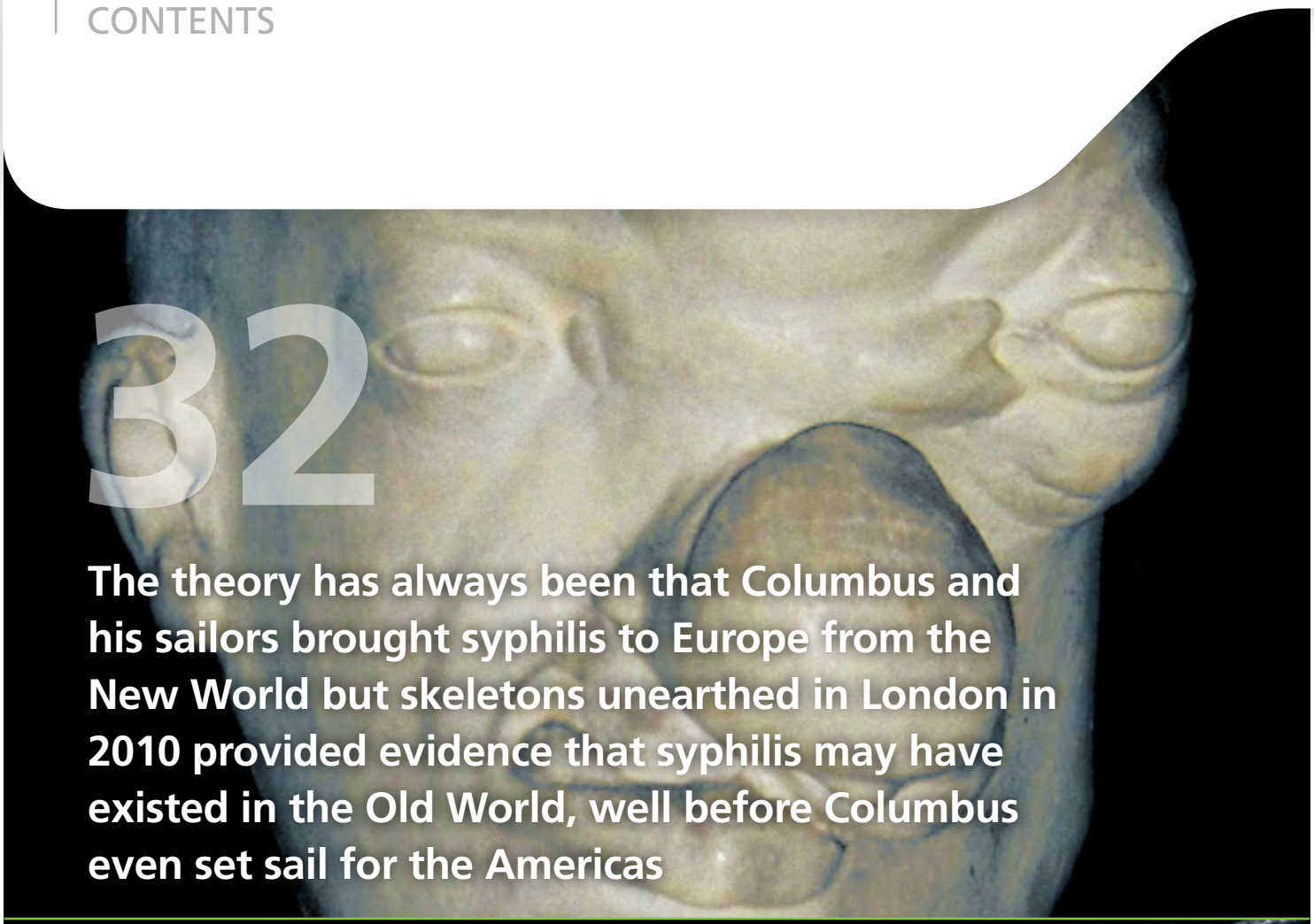
Engaging the next generation
Dr Lucy Harper, Chief Executive of the Society for Applied Microbiology discussed with Wiley Publishing how S*f*AM works to engage the next generation of microbiologists.
http://bit.ly/2f0m0vM

Antibiotics course
Finish an antibiotics course? Maybe not, say BMJ. "*Not so quick,*" says new S*f*AM President Professor Mark Fielder.
http://bit.ly/2tN8Yby

It's in the air
Study reveals air pollution can alter the effectiveness of antibiotics and increases the potential of disease.
http://bit.ly/2IY1NIb



Paul Sainsbury, *Editor*
Rosie Stevens, *Supergirl*



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The theory has always been that Columbus and his sailors brought syphilis to Europe from the New World but skeletons unearthed in London in 2010 provided evidence that syphilis may have existed in the Old World, well before Columbus even set sail for the Americas

NEWS

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FEATURES

PUBLICATIONS

MEMBERS' WALL

COMMERCIAL

President's column

Things can certainly move quickly in S*f*AM! Only a short while ago I was sitting in the AGM at the Annual Conference in Gateshead wondering how I would follow Professor Christine Dodd as President and here I am a few short weeks later penning my first President's Column. I would firstly like to start by saying what an honour and privilege it is to serve S*f*AM and the membership as your President. So thank you so much for affording me this opportunity. I want also to pay tribute to the work of our outgoing President Christine, her work in steering the Society through some interesting times recently has been remarkable. She oversaw a change in Chief Executive following the retirement of Mr Phil Wheat and then held the helm steady as we moved the offices from Bedford to Charles Darwin House in London. Similar praises for the work of the CE herself, Dr Lucy Harper should also not go unsung. The day to day detail of moving the office fell to her and her team and was flawless as far as the rest of us were concerned with little or no disruption in the day to day service the team provided. I fully appreciate the massive effort this took to achieve. So now we have a new office a largely new (excellent) team and a new President! I have large boots to fill and Christine's parting words to me at the Annual Conference of "*don't mess it up*" are still ringing in my ears. I will endeavour not to Chris, I promise.

So, what are the challenges going forward? Well we are unlikely to need a new CE (hopefully) and another move is not in the planning so all should be quiet I thought, well no! We now must face the challenges of Brexit and what they may or may not mean for the future of science – especially microbiology. We also need to ensure the voices of British, European and Global science are heard. We have Members to represent in all these groups so we shall strive to do so on your behalf.

One of our undoubted successes over the years has been the rise of the Early Career Scientists group (ECS). This has evolved from an informal group of like-minded students to the tour de force within the Society that they are today. This early group of pioneering postgrads such as Dr Jess Rollason, Dr Katie Laird, Dr Jo Heaton Marriott, Dr James Collins amongst many others pretty much started it all off and they – as well as other current and former Members – have careers as academics and researchers now running their own groups. This is fantastic and their early work has been developed and expanded over the last 10 years and is now run by the current ECS group and committee who work so hard to

I have large boots to fill and Christine's parting words to me at the Annual Conference of "*don't mess it up*" are still ringing in my ears

give such vibrancy to all they do, the sessions they organize at the Annual Conference, the organizing and running of their own conference and the valuable input on various committees. Keeping in touch with the next generation and walking side by side is vital to the maintenance of an active Society where the interaction between new and established scientists is positively encouraged. We can all learn from each other and I will strive to keep that vision going forward. At an Annual Conference in Manchester a number of years ago Professor Basil Jarvis, a stalwart of the Society, gave a masterclass on statistics to the Postgraduate and Early Career Scientists (PECS) as they were then known. Such was the rapport between the PECS group and Basil that they all went out on the town in Manchester. The title of 'Basil the legend' was respectfully bestowed on Professor Jarvis that night and it was wonderful that in Gateshead this year he is still known by that title. A wonderful example of not only how we are the friendly Society, but also the approachable Society. I am very proud of that and the team and I will work hard to make sure your Society continues to thrive and develop in promoting and protecting our science, having roles in policy, public engagement, providing grants and hosting meetings of importance and relevance to our Members. I look forward to seeing you at meetings and gatherings in the near future.

So, in closing I would thank Christine once again and I will do my utmost to "*not mess it up*"!

Mark Fielder
President of the Society

Harper's Postulates

Notes from the Chief Executive

Having returned to the office after the S*f*AM Annual Conference in Gateshead, I'm still reeling from the buzz of four days of food safety, art, food and let's face it, fun. We had an unprecedented delegation from 24 countries, from universities, Government laboratories and industry all gathering to hear world-class science, network, make new connections and meet up with friends. Delegates from all career stages were there: from undergraduates and early career researchers to established researchers and retired S*f*AM Members. The programme was packed with superb presentations on topics such as the use of bacteriophages in food processing, food irradiation, and the latest on food pathogens such as *Campylobacter* and *Listeria*.

The Baltic Centre was the venue and for those who don't know, this is an art gallery which was originally a flour mill and stands imposingly on the banks of the River Tyne, close to the Gateshead Millennium Bridge.

How appropriate then that throughout the conference we were accompanied by local artist, Louise McKenzie. The Society commissioned her, through ASCUS Art and Science to attend the conference, mingle with the delegates, speakers and immerse herself in the science and the overall conference experience with a view to finding inspiration for a future piece of work. Louise exhibited a piece at the conference and this, together with a presentation she gave about her work, became inspiration to delegates. Those who'd spoken with her and heard her presentation were all impressed by her ability to make them think slightly differently about food safety, molecular biology and genetics. We await her creation in excited anticipation and you can read an interview with Louise, in a future issue of the *Microbiologist*. We will use her piece to illustrate the cross-over between art and science – a burgeoning area which will engage new audiences in the content of our meetings and events in applied microbiology.

The Society has been engaging the public in applied microbiology for a number of years, and recently we attended an event which was new to us, as part of the Royal Society of Biology's 'Biology Big Top'. At the Lambeth Country Show, we exhibited a Heroes and Villains game inspired by DC comic characters Superman and Supergirl, both of whom were in attendance (see pic). This attracted hundreds of families who joined in the game to learn about the microbes that cause disease and those we can't live without.

Another public engagement event which we are proud to be taking part in, marks International Coffee Day (1 October 2017). The event, which will be held over two days preceding ICD itself, 28–29 September 2017, is a collaborative project between the co-owning societies at Charles Darwin House (Royal Society of Biology, Biochemical Society, British Ecological Society, Microbiology Society and Society of Experimental Biology). There will be a drop-in event, and a public lecture, covering many biological aspects of coffee, from the physiological effects of caffeine, through to the sustainability of coffee production. Audiences will be taken on a biological journey from bean to cup.

Lucy Harper
S*f*AM *Chief Executive*

ECS Adventures in Gateshead

The Society for Applied Microbiology Annual Conference in Gateshead was spectacular this year. Apart from being held in a fantastic location; the BALTIC Centre for Contemporary Art in Gateshead, the conference was jam-packed with workshops, posters and hugely engaging talks given by S*f*AM Members and prize winners. As there is so much to talk about, I will focus solely on the Early Career Scientist sessions which were of a very high standard!

The conference kicked off on Monday morning with the Science Communication Workshop organized by the ECS Committee. To start off we were treated to talks by Fiona Lethbridge from the Science Media Centre, Joanne Thomas from Sense About Science and Sagar Aryal, creator of the online Microbiology Notes resource microbiologyinfo.com. Each talk highlighted a different aspect of science communication from providing accurate, expert quotes for journalists, encouraging the public to ask for evidence and how to succeed with science in social media. Following this, everyone split into three groups, each with one of the different speakers, and undertook a workshop in each of the three areas.

The ECS Committee also host an icebreaker session on the first day for our early career delegates. The icebreaker involved throwing beach balls at each other and asking very random questions to try and get to know each other. Afterwards it was great to see everyone talking with ease to people they had only known a few hours.

The next ECS session was the student presentations starting with Putu Virginia Partha Devanthi from the University of Birmingham. The presentation covered her research into using a double emulsion to stop antagonistic interactions between starter culture organisms for moromi fermentation of soy sauce. The talk was both interesting and engaging and won Putu the prize for best student presentation!

Next up was Geraldine Lafontaine presenting her research on the timing of broiler exposure to *Campylobacter jejuni* and how this affected their inflammatory immune response. Bernadino Machado-Moreira's presentation of his work on microbial contamination of fresh fruit and vegetables highlighted the need for more information on outbreaks related to ready to eat food. The clearly presented conclusions made this talk easy to understand and the great standard of delivery carried on into the last talk presented by Lionel Kenneth Dygico. His research delved into the possibility of using bacteriocin-producing bacteria found in mushrooms as a biocontrol for *Listeria monocytogenes*.

Along with the ECS student presentations session, there were many excellent posters being presented by our Early Career Scientist Members. Our congratulations go out to Gurpreet Sandhu who won the prize for best poster presentation! Overall, the four days were hugely enjoyable and it was great to meet so many interesting people during the breaks between sessions.

We now can't wait for our next event which will be the very popular ECS Symposium next April. The 7th ECS Research Symposium will have the exciting theme of Epidemiology and more details will be announced very shortly!

Jennie French
ECS Committee Member
University of Nottingham

POLICY Corner

Microbiology is global let's keep it that way

In late June, we joined representatives from across the scientific community for Parliamentary Links Day, the single largest science policy event in the UK Parliamentary calendar. At the tightly packed event, eminent members of the STEM community discussed the opportunities and dangers facing the future collaboration of UK-based and international researchers. We also heard some of the concerns of European scientists and engineers who live and work in the UK. Above all, a clear message rang out that excellence in STEM hinges on the *freedom of researchers to collaborate and travel across borders*.

Since the result of the British EU Referendum last year, the scientific community has called for reassurances on broad, high-level issues including support for funding and researcher mobility. Throughout this period, SfAM has been supported as part of a 'united front' for scientists alongside organizations such as the Royal Society of Biology (RSB) and the Campaign for Science and Engineering (CaSE). As the Brexit process continues over the next few years, we will have the opportunity to engage policymakers on the specific threats and opportunities facing applied microbiologists.

We sought your views on what these priority areas are, in a survey we ran throughout May. Overall, we received 205 responses, of which 92% (189) came from Members who are based in the UK. Nearly 1/3 of the responses received came from non-UK nationals who reside in the UK, reflecting how important freedom of movement is to microbiology and to our Society.

33% *of responses were from non-UK nationals residing in the UK*

Mirroring the themes identified during Parliamentary Links day, your feedback highlighted collaboration and freedom of movement as important areas for SfAM's future policy work. For example, 65% of respondents viewed *collaboration and rapid response to pan-European issues*, such as responding to disease outbreaks, as a high priority. Similarly, being able to *access and maintain facilities inside or outside of the UK* was deemed a high priority, supported by 72% of responses. Such facilities include the culture collections, reference laboratories and various data networks and repositories – all integral to the research and application of microbiology.

Excellence in STEM hinges on the freedom of researchers to collaborate and travel across borders

Other issues were raised in the survey, including the ever-present concerns over research funding and supporting an unrestricted flow of students and researchers. In addition, we should emphasize the importance microbiologists have in collaborating across borders on important topics such as antimicrobial resistance, food safety, GMO products, environmental preservation and advanced therapy medicinal products (ATMPs).

There are evidently many topics and areas to cover over the next few years, and engaging policymakers with the right information at the right time is crucial to making a difference. For SfAM to have a meaningful voice, we rely on the input and experience of our dedicated membership. Therefore, we are establishing an informal network of our Members who have dealt with microbiological issues on the international stage. This network will support SfAM's policy engagement on Brexit by contributing towards consultation responses, policy briefings and by guiding our engagement with partner organizations such as the RSB and CaSE. If you have experience of advising policy decisions at the UK, EU or international level, then we'd love to hear from you! Keep your eyes peeled for further information on the SfAM website.

Chris Brown
SfAM *Policy Officer*

An uncertain Brexit

This year has so far proved to be more eventful than many of us anticipated.

With the unexpected announcement of the general election, we worked hard with our partners to ensure that the priorities of the UK science sector were part of the conversation in the run-up to the opening of polling stations.

We contacted candidates in the election and the major party leaders directly, making the case to them that we need to ensure the UK science base remains world-leading, and to ensure all decision-making continues to be informed by evidence and after seeking advice from the scientific community where appropriate.

With the Brexit negotiations having begun we also highlighted the need for reassurance for EU national colleagues who currently live and work in the UK. This significant proportion of the UK biosciences community provide an invaluable contribution to the research and innovative work we do, but thousands still do not know if they will be able to remain here come March 2019.

Such uncertainty is leaving countless research groups in a state of limbo when considering their long-term plans and goals, and risks slowing down the progress of UK science as a whole.

Through our Brexit analysis we're looking to capture the impact negotiations may have on the progression and growth of our sector, and we're keen to hear from those who are affected by these issues, including Members of the Society for Applied Microbiology.

We want to hear from as many researchers, academics and others working in the biosciences as possible, in a bid to understand more about how the changing prospects of the community is impacting research and application.

The maintenance and indeed the improved strength of UK biosciences has always been a priority for us at the RSB; we celebrated the award of Accreditation for another 16 institution's bioscience degrees this year, bringing the total number of students enrolled in accredited courses to around 10,000, including many students specializing in microbiology.

We now have 215 Accredited degree programmes across more than 30 higher education institutions to date, and recently awarded the recognition to international programmes including, for example, the Xi'an Jiaotong-Liverpool University in China. A further 213 programmes have also been awarded Advanced Accreditation.

BIOFocus

As part of our direct engagement with member organizations we came together with the Society for Applied Microbiology and others for another Twilight meeting in May focused on Equality, Diversity and Inclusion (ED&I). This offered an important opportunity to share both the challenges we face as membership bodies and also stories and cases of improvement and good practice for ED&I initiatives.

The RSB continues its commitment to the ED&I framework championed by the Science Council, and we will be putting in place additional initiatives to increase diversity and inclusion in all areas of our activity.

In May we held our Annual General Meeting, which drew an unprecedented crowd and saw over 100 members of the RSB attending; indeed we had to upscale arrangements to a larger venue than anticipated to ensure all could fit!

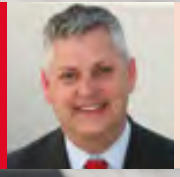
At the event we were delighted to announce that Professor Dame Julia Goodfellow will take up the presidential reins from May 2018.

We shared with those in attendance at the AGM how much we've grown as a membership organization; we've seen a significant growth in our membership over the past year, and more membership organizations have joined the RSB alongside the Society for Applied Microbiology.

All of our work is done on behalf of our members and we want members and organizations to feel ownership of the outputs, and to feel they are playing a part in ensuring that they UK biosciences sector continues to go from strength to strength.

We will continue to work hard to represent the UK biosciences community to those in the upcoming negotiations, and try to ensure the deal secured is the best deal for our sector and all of our collective members.

Uncertainty is leaving countless research groups in a state of limbo when considering their long-term plans and goals



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

THE ATTRACTION OF THE Beard

When I was asked to write an article about the microbiology of beards my first reaction was to stroke my own and quietly state '*hmmm*'. Beards have a long history and are always a topic of lively discussion; through my own experience I have found they can be things of both personal ridicule and individual contentment – often at the same time. They were thought to be evolutionary vestiges from a time when our ancestors were hairier, they are firmly placed within a variety of religious dogma and are extremely fashionable depending on who you are talking to, what you read or watch, and who is growing one.

Interestingly, humans are not alone in their ownership of these hairy outgrowths; other mammals including, but by no means limited to, monkeys, dogs, goats, ibex and pigs are also members of the bearded club. A widely accepted view is that sexual selection has contributed to the evolution of beards and both attractiveness and dominance may play a role.

Despite the intense general interest in beards there is surprisingly little microbiological research carried out on them outside of the health and safety aspects of contamination of a clinical environment which I will describe here.

In 1967, Barbeito and colleagues prompted by a change in laboratory personnel facial fashion, carried out one of the first studies of beard-mediated microbial transmission on four volunteers with 73-day old beards, which were seeded with the red-orange pigmented *Serratia marcescens*, and what is now classified as *Bacillus atrophaeus*, a black pigmented isolate closely related to *Bacillus subtilis*. Their studies revealed that washing the beards for at least 30 mins after spraying them with bacterial culture facilitated removal of either bacterial strain regardless of the washing methodology.

Another study, published in 2000, investigated links between bacterial shedding, beards, gender and surgical 'mask wiggling'. It showed that bearded individuals wearing surgical masks are likely to shed more bacterial cells than clean-shaven males and females wearing masks. Furthermore, if mask wiggling does occur, then bearded mask wearers and females shed significantly more than if no wiggling occurs. The conclusions from this study were that females and bearded males should avoid mask wiggling and bearded males should consider removing their beards altogether. It is worth noting in this study that the bacterial isolates recovered were predominantly coagulase-negative staphylococci and non-haemolytic streptococci. In contrast to the above conclusions, in 2014, Wakeam and co-authors demonstrated that bacterial colonization of healthcare workers is similar between bearded and non-bearded males although certain *Staphylococcus* spp., were more prevalent on non-bearded faces. The question of whether 'to beard or not to beard' was addressed by Parry and colleagues only last year. They analysed shedding of bacteria from faces protected by surgical masks with, and without, non-sterile hoods. They showed that whilst higher bacterial shedding occurred in the unmasked compared with the masked, and the masked and hooded group, there was no statistical difference between the clean-shaven and bearded groups. They also identified the organisms that grew both aerobically and anaerobically on non-selective blood agar plates from both groups using MALDI-TOF. They demonstrated that *Staphylococcus* spp. were the most commonly isolated, confirming previous results (Table 1).

Recently I undertook my own, slightly left-field, foray into the microbiological world of beards in conjunction with the BBC's '*Trust Me I'm a Doctor*' series and my

TOP 5 AEROBIC Bearded (total 13) and clean-shaven (total 9)	TOP 5 ANAEROBIC Bearded (total 10) and clean-shaven (total 9)
Staphylococcus epidermidis	*Staphylococcus epidermidis*
Staphylococcus capitis	*Propionibacterium acnes / Staphylococcus aureus*
Staphylococcus aureus	*Staphylococcus capitis / Propionibacterium acnes*
Corynebacterium pseudodiphtheriticum	*Staphylococcus aureus / Staphylococcus capitis*
Micrococcus luteus	*Klebsiella oxytoca / Staphylococcus hominis**

*Equal 5th place with other *Staphylococcus* spp. and *Streptococcus* sp. Adapted from Parry *et al*., 2016.

citizen science drug discovery project 'Swab and Send'. After a good rummage around unsuspecting beards in Camden and Bloomsbury districts of London we grew all we could and analysed the isolates for the production of antimicrobials against a range of indicator strains. As in the previous studies outlined above, the vast majority of our isolates were staphylococci (as determined by 16S rRNA gene sequencing) with a few odd ones that we suspect were transient 'hangers on' as a result of normal activities such as eating and touching the beard.

We isolated multiple *Staphylococcus* spp. which were able to inhibit some of our indicator strains due to the production of antimicrobials. This concept caught the imagination of the viewers and the coverage that this small story received was astonishing. Over 6 million individuals watched a short movie about beards, AMR and antibiotic producers on the BBC Facebook site following airing of the '*Trust Me*' programme and the following day other media outlets were reporting with zeal, that beards could save the world and be good for your health which was more than frustrating. Despite these exaggerated claims, the central AMR message managed to get through to an incredibly large audience and once again demonstrated the extraordinary attraction of the humble beard.

FURTHER READING

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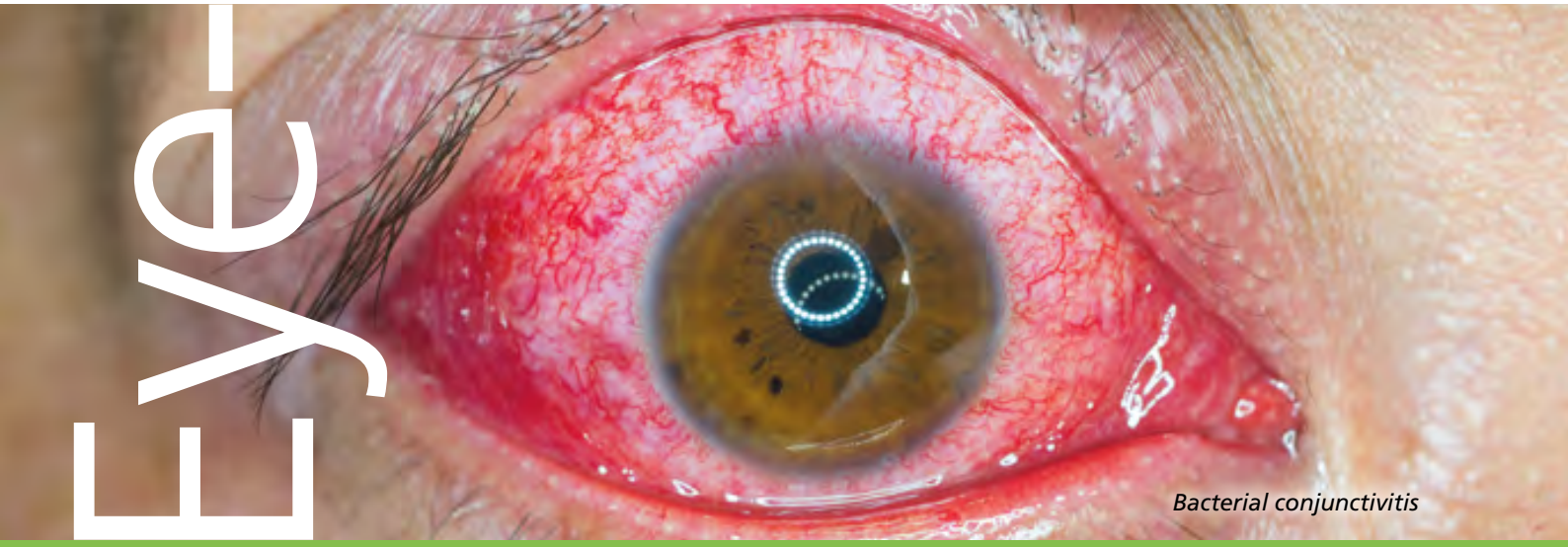
https://www.facebook.com/swabandsend/

https://thebritishbeardclub.org/

Adam P. Roberts
Liverpool School of Tropical Medicine

Eye-catching

Ophthalmic infections are very common and can lead to sight-threatening complications if not treated promptly. Intraocular tissues are relatively immune-privileged; however, they can be infected by any organism that manages to enter the eye. Risk factors include trauma, surgery and systemic diseases. This article reviews the clinical features, causative pathogens and treatment of a few common conditions, and a few sight- and life-threatening eye conditions.



Bacterial conjunctivitis

Lid infections

The first way that microorganisms can affect the eyes is via lid infections, which can be mild, such as blepharitis, or serious, such as preseptal or orbital cellulitis.

Bacterial blepharitis, which is mostly anterior blepharitis, is a common condition that affects people of all ages. The main culprits are lid commensals, especially staphylococci, but streptococci, *Propionibacterium acnes* and *Moraxella* spp. have also been implicated.

Signs and symptoms involve burning, foreign body sensation, infected lid margins, external hordeolum and visible scales at the base of the lashes.

Treatment is relatively straightforward and involves lid hygiene and lubricants for mild disease. Antibiotics and weak steroids may be required in moderate and severe cases, or when the ocular surface is affected.

A more serious and life-threatening disease that can affect the lids is orbital cellulitis, where the lids are tense, swollen, red and inflamed. In the severe form of this disease, there is proptosis and loss or reduction of eye movement and optic nerve function. This can occur via spread from adjacent structures, such as the sinuses or lacrimal system, trauma to the lids or orbit.

The range of organisms is similar to blepharitis, but most common are *Streptococcus* and *Staphylococcus* species. *Haemophilus influenzae* used to be the most common in children, but incidence has been reducing since introduction of the Hib vaccine.

Management of orbital cellulitis needs to be aggressive, with immediate admission, intravenous antibiotics, and imaging to assess the extent and source of infection.

Conjunctivitis

Conjunctivitis is a non-specific term for inflammation of the conjunctiva and is grossly subdivided into three categories: bacterial, viral and allergic.

Bacterial conjunctivitis is very common and most cases are acute and self-limiting. However, it has a large societal impact in terms of missed school or work days, due to its high prevalence. The most frequent conjunctival pathogens are *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Haemophilus influenzae*. Rarer pathogens include *Pseudomonas aeruginosa*, *Moraxella lacunata*, alpha-haemolytic streptococci and *Proteus mirabilis*. These organisms are spread by direct eye contact with infected secretions. There are some variants according to age (e.g., *H. influenzae* in children) and climate (e.g., *Haemophilus aegyptius* in warm climates versus *H. influenzae* and *Streptococcus* spp. in cool climates).

Patients typically present with an acute red, gritty, sticky eye, which rapidly affects the other eye. On examination, they will have purulent discharge, crusted lids and infected conjunctiva. Investigations are not performed routinely but may be necessary in severe or atypical cases, as well as for immunocompromised patients and neonates. Almost all cases of acute bacterial conjunctivitis are self-limiting and will clear within 10 days without treatment. However, there are some more virulent organisms which may result in chronic colonization and symptoms. Furthermore, topical antibiotic treatment has been shown to decrease the duration of symptoms and prevent re-infection or transmission.

Viral conjunctivitis is most frequently caused by adenovirus, a double-stranded DNA virus with over 50 serotypes identified. The incubation period is approximately one week and the virus can be shed for up to two weeks following the onset of conjunctivitis. Adenovirus is extremely contagious and transmitted by

A stye, also known as a hordeolum

Large corneal ulcer with hypopyon.

close contact with ocular/respiratory secretions or fomites. The spectrum of presentation can be subdivided into two separate syndromes:

Pharyngoconjunctival fever (PCF) – caused by serotypes 3, 4 and 7 and spread by droplets within families with upper respiratory tract infections. Keratitis is mild and only present in up to 30% of cases.

Epidemic keratoconjunctivitis – caused by serotypes 8, 19 and 37 and transmitted by contact. It is more severe than PCF and associated with keratitis in about 80% of cases.

Patients typically present with watering, burning, itching and, more rarely, photophobia. On examination, they may have eyelid oedema, tender pre-auricular lymphadenopathy, follicles and more rarely, pseudomembranes and membranes. The latter can leave scarring in the long term. Investigations are usually unnecessary, unless the presentation is atypical. They include conjunctival swabs for viral antigen determination. In contrast, a 'point of care' immunochromatography test is quick (taking less than 10 minutes) and can detect the adenoviral antigen with a high sensitivity and specificity. It is important to advise patients appropriately regarding frequent handwashing, minimal touching of eyes and not sharing towels/flannels etc.

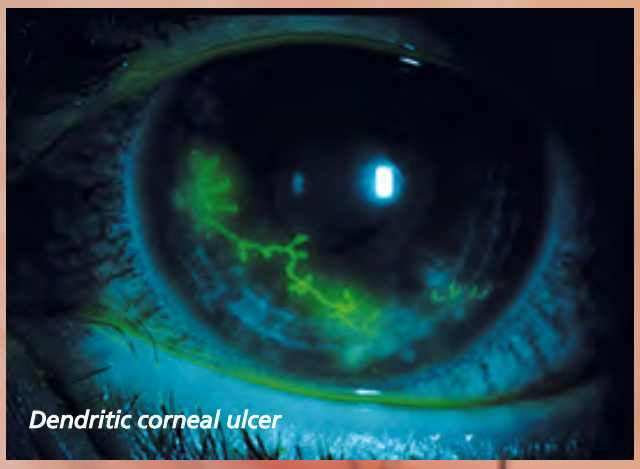
Treatment is not always required and comprises supportive measures (cool compresses and artificial tears), as well as a low dose topical steroid for symptomatic relief or severe cases of membranous or pseudomembranous adenoviral conjunctivitis. However, lesions can recur when steroids are stopped, promoting long-term dependency. Topical antibiotics are sometimes prescribed to prevent secondary bacterial infections.

Corneal infections

Corneal infections are another sight-threatening ophthalmic emergency. However, with quick diagnosis and prompt intensive treatment, they can now be effectively and completely treated, leaving only mild visual disturbance.

Presentation is with sudden onset pain, redness, tearing and reduced vision. History may reveal the aetiology and cause, e.g., contact lens use is associated with a high incidence of acanthamoeba keratitis, trauma with plant matter raises the suspicion of bacterial and fungal keratitis, herpetic viral infections on the face and lids suggests a viral ulcer.

Ocular surface disease such as herpetic eye disease, dry eyes, reduced corneal sensation and exposure from poor lid closure are other major risk factors for microbial keratitis. The pathogens seen are again commensals on and around the eyes, such as *Staphylococcus aureus* from the conjunctiva, nose and



Dendritic corneal ulcer

Infections of the eyes range from mild lid infections that are relatively harmless to the severe sight- and life-threatening orbital cellulitis

skin, *Pseudomonas aeruginosa* from the gastrointestinal tract, and *Streptococcus* species from the throat and vagina. The latter two result in an aggressive form of corneal ulcers and can destroy the cornea within a few days if not detected and treated immediately.

The first investigation for a corneal ulcer is corneal scraping for microscopy. Some clinicians may not scrape small ulcers (less than 1–2 mm in diameter) that are away from the visual axis, but start intensive hourly daytime and night-time drops, and review the patient the next day for a response.

Larger ulcers involving the visual axis should be scraped, ideally with a new spatula for microscopy and then for each culture medium. Commonly used media are blood agar for most common bacteria, chocolate agar for more fastidious pathogens, like *H. influenzae*, *Neisseria* species and *Moraxella* species and Sabouraud Dextrose agar for fungi.

Herpetic ulcers resulting from infection with HSV1 have a characteristic branching morphology and are known as dendritic ulcers. The clinical picture is obvious so herpetic ulcers do not require scraping for diagnosis. They respond well to anti-viral eye ointment, five times a day. Ganciclovir and acyclovir eye ointment is usually effective, with minimal side effects.

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Prognosis for corneal ulcers is generally good if detected early, and other risk factors are absent. First-line treatment is usually with a fluoroquinolone, such as ciprofloxacin, moxifloxacin or ofloxacin. Moxifloxacin is known to have superior ocular penetration.

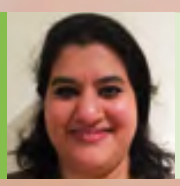
For aggressive ulcers duotherapy is considered as first line, and the main choices are antibiotics such as cephalosporins and aminoglycosides.

Endophthalmitis

Although rare, endophthalmitis is one of the most devastating complications of intraocular surgery, with onset usually commencing 1–7 days post-operatively. The most common organism is coagulase-negative *Staphylococci*, followed by other Gram-positive organisms (*Staphylococcus aureus* and *Streptococcus* species) and Gram-negative organisms (*Pseudomonas* spp. and *Proteus* spp.). Perioperative measures have been recommended to reduce the rate of endophthalmitis. These include lid hygiene for reduction of conjunctival flora, instillation of 5% povidone iodine 3–5 minutes prior to surgery, meticulous surgical draping and prophylactic intraoperative antibiotics.

Symptoms include pain, worsening vision, disproportionate inflammation with hypopyon, posterior segment inflammation and lid swelling. A relative afferent pupillary defect suggests a poor prognosis. Risk factors include patient flora (blepharitis, conjunctivitis, nasolacrimal disease), comorbidities (e.g., diabetes) and complicated surgery (posterior capsule rupture with vitreous loss, prolonged surgery). It is necessary to perform an urgent anterior chamber tap and vitreous biopsy with simultaneous administration of intravitreal antibiotics. The most frequent combination is ceftazidime (Gram-negative cover) with vancomycin (Gram-positive cover). Topical antibiotics and corticosteroids can also be added (with the exception of fungal infections). Oral antibiotics (e.g., fluoroquinolones) are used as they penetrate the eye well. Immediate pars plana vitrectomy is indicated in patients with an initial visual acuity of light perception or in diabetics. In effect, the Endophthalmitis Vitrectomy Study found a three-fold improvement in these patients.

As infections of the eyes range from mild lid infections that are relatively harmless to the severe sight- and life-threatening orbital cellulitis, microbiological assessment of specimens is an essential and invaluable tool, which improves the diagnosis and prognosis.




Leena Bhat left and **Camille Yvon** right
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BACTERIAL BIOFILMS in the middle ear

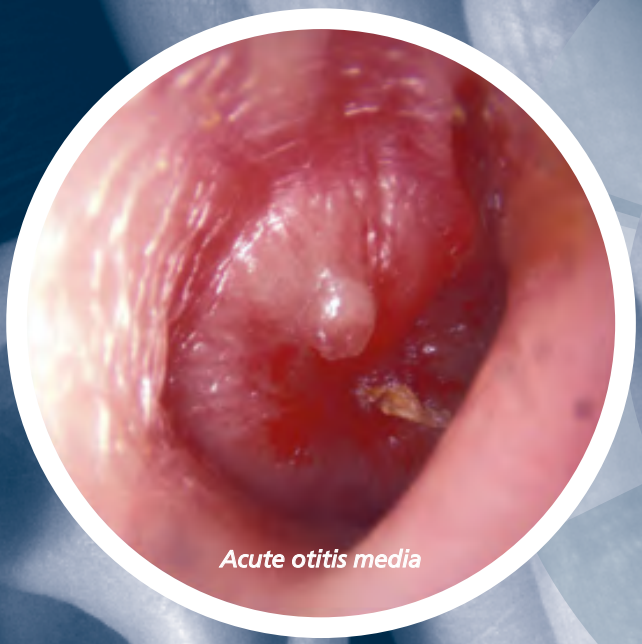
Over the last 20 years, research into otitis media has suggested that biofilms in the middle ear play an essential role in infection by acting as bacterial reservoirs. However, recent studies query whether biofilms really are the missing link, or whether they are distracting us from identifying the real cause of infection.

Otitis media is an infection of the middle ear causing inflammation and fluid build-up behind the tympanic membrane (eardrum). Infections can develop at any age, but are most common in infants between the ages of six and fifteen months. By the age of 10, at least one in four children will have experienced an acute infection. Acute otitis media (AOM) is often caused by viral infection; symptoms develop quickly and resolve within a few days without the need of antimicrobial intervention. Acute otitis media with effusion (AOME) is a clinical variant which is likely to be caused by bacteria. Bacteria from the throat enter the eustachian tube (which links the nasopharynx and the middle ear) and evade the middle ear defence mechanisms. Common causes include *Streptococcus pneumoniae*, *Haemophilus influenza* and *Moraxella catarrhalis*; however, *Streptococcus pyogenes*, *Staphylococcus aureus* and Gram-negative bacilli may also be implicated. In these cases, patients benefit from antimicrobial therapy. Complications can lead to chronic otitis media (COM) which may be suppurative (CSOM). COM can be very damaging to the ear resulting in hearing loss. In CSOM, a discharge occurs from chronic infection of the middle ear via a chronic perforation of the ear drum. Episodes of discharge can occur over weeks or months, are recurrent and are resistant to antimicrobial treatment. The most common causes of infection are *Pseudomonas* species and meticillin-resistant *Staphylococcus aureus* (MRSA); anaerobic bacteria are seen in up to 25% of cases. One theory regarding the persistent nature of chronic infection is that infection results from complex, organized bacterial biofilms formed within the middle ear.

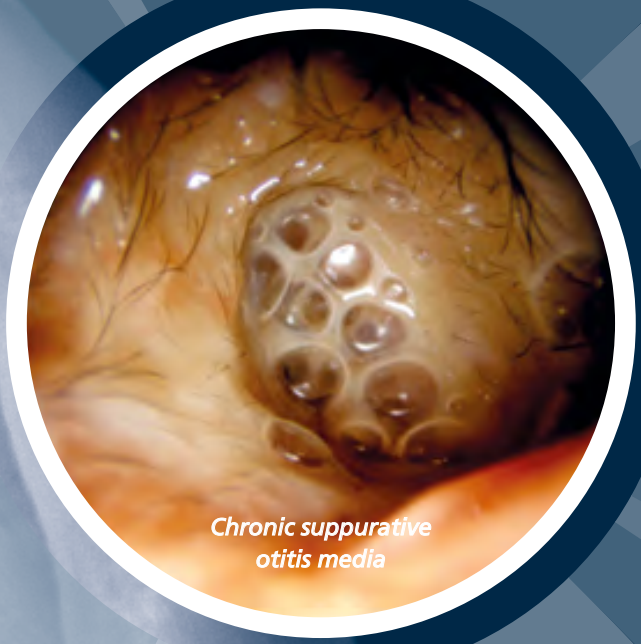
Biofilms are found in many systems and are comprised of mixed microbial communities attached to a surface and bound by a self-produced (slime-like) extracellular matrix. Due to the organization and 3-dimensional structure of biofilms, bacteria within them are protected; they are therefore resistant to environmental changes such as temperature and pH and are metabolically resistant to antibiotics. The first indication of an association between COM and biofilms in the middle ear was reported in 1998 by Rayner *et al*. who established the presence of metabolically active bacteria in some culture-negative OM effusions using real-time PCR. Biofilm formation has since been shown to play an important role in a number of other chronic human infections including chronic tonsillitis and in device-related infections. Research into COM has shown evidence of the presence of biofilms in the middle ear of patients with chronic infection. In 2006, a study of children in the US reported that 46/50 (92%) of children suffering from COM tested positive for biofilms in the middle ear; no biofilms were observed in the control group. The study suggests that COM may be the result of mucosal biofilm infection, bringing the utility of antibiotics in these cases into question. More recently however, the clinical relevance of middle ear biofilms has been questioned, as data which proves a cause and effect relationship is scarce.

Researchers from the University of Gazi, Turkey, evaluated biofilm formation by direct microscopy and transmission electron microscopy in COM patients, with and without ear discharge, in a paper published in 2012. The group demonstrated that biofilm formation is not present in all COM cases. The control group were biofilm free and biofilms were present in all those with ear discharge, however this was not the case for those with dry perforations where biofilms were observed in only 2 of 9 participants (22%). This indicates a possible relationship between biofilm formation in COM patients and ear discharge, but does not address the identity of the organisms present at the time of infection, or the role of biofilms in subsequent episodes with ear effusion. One group from Denmark looked at precisely this. In a Danish University and hospital collaboration, bacterial strains in recurrent episodes of COM were identified. Patients were observed for between 14 and 280 days (median 140 days) and 13 patients had one or more occurrence. Of those with a reoccurrence, three had the same genotype of bacteria in a subsequent episode, two had the same phenotype of non-typeable *Haemophilus influenzae* and eight had multi-species infections of organisms not previously identified.

Biofilm presence is clearly associated with COM infection; however, as the studies above demonstrate, the exact role of biofilms in COM is not completely understood and is likely to be more complex and dynamic than initially thought. A causal role is yet to be proven and the possibility of re-infection with new pathogens in chronic infection should not be dismissed.

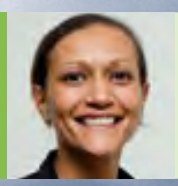


Acute otitis media



Chronic suppurative otitis media

Episodes of discharge can occur over weeks or months, are recurrent and are resistant to antimicrobial treatment



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SNIFFING OUT lung infection

Lung microbiology

Our lungs are continuously exposed to chemical contaminants, as well as microbes, from the air we breathe. Adherence to lung tissue and microbial colony formation consequently occur throughout the respiratory tract and whilst there is rich microbial colonization of the lungs there are also invasive pathogenic organisms as well. The warm and humid environment within the airways provides ideal conditions for growth, including a plentiful supply of oxygen. Microbial exposure is likely to be dependent on the immediate environment, and will differ between, for example, hospitals and the community. Dependent upon these influences, the development of the lung microbiota relies upon two main survival factors – microbial transport in and out of the lungs (and therefore colonization), and the reproductive rates of these resident microbes.

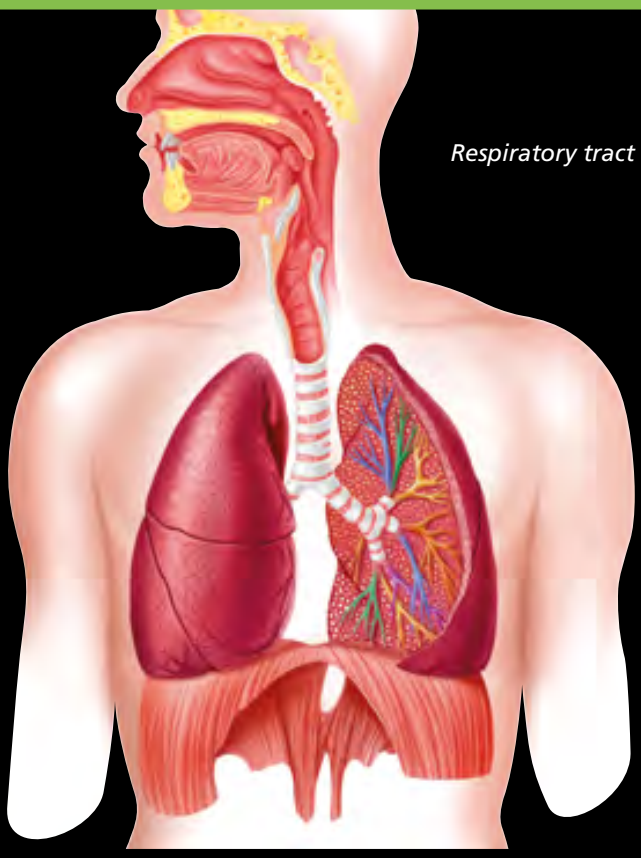
Cells that form the inner lung barrier contain a number of immune signalling and recognition mechanisms which are involved in regulating the balance between the host's adaptive immunity and (what becomes) the commensal microbial flora. If this balance is disrupted by an unrecognized microbial species (triggering an innate immune response), symptoms and signs of a lung infection will occur.

In health, the immune system responds to such exogenous invasion by activating pro-inflammatory signalling pathways and mobilizing associated immune cells. However, a weakened immune system and infection pathogenicity act synergistically leading to severe infection. This is seen in acute infections such as invasive pulmonary aspergillosis (where the main pathogen is *Aspergillus fumigatus*) or ventilator-associated pneumonia, and chronic infections such as *Pseudomonas aeruginosa* in cystic fibrosis patients. These opportunistic pathogens are ubiquitous to the host, and normally would not cause harm with a healthy immune system.

Clinical diagnosis

Initial suspicion of lung infection by a medical professional often involves the identification of progressive symptoms and deteriorating lung health, which may include difficulty in breathing and coughing. Pulmonary pathology tests such as chest scans may show abnormalities. If required, lung-derived samples such as sputum or bronchoalveolar lavage (BAL) are sent for biochemical and genetic analyses. Following this, antibiotic treatment is given to the patient (almost always before the results of the sample culture are available) to reverse the course of the infection.

This diagnostic process can be subject to errors throughout the whole system, from initial intervention to treatment. As the lung can be infected by bacteria, fungi and viruses, appropriate antimicrobial therapy is important as the wrong antibiotic can lead to increased microbial resistance. Differential diagnosis therefore relies upon numerous tests which indicate a specific pathogen, where medical history and chest pathology characteristics play a crucial role. Delayed diagnosis may also occur, with a likely detrimental effect on patient morbidity. These examples of inefficient diagnosis contribute to higher healthcare costs, which includes the time of medical staff, costs per test, drugs and length of stay. Therefore a faster, more accurate and efficient indication of early infection would be beneficial to the patient and improve their overall healthcare.



Respiratory tract

Breath analysis

Since the advent of modern medicine, physicians have reported that breath scents are associated with disease – the fruity aroma of ketoacidosis (acetone) or the musty smell of hepatic encephalopathy (dimethyl sulfide).

The main advantage of breath analysis for clinical diagnosis is the ability to sample breath gas non-invasively, in contrast to inserting a catheter into the body, such as in blood, urine or BAL sampling, which is pretty uncomfortable for the patient.

Our lungs are continuously exposed to chemical contaminants, as well as microbes, from the air we breathe

The development of powerful analytical and chemometric tools have allowed researchers to look deeper into the chemical cocktail of breath gas. Pioneers such as Antoine Lavoisier and Linus Pauling identified chemicals within breath linked to clinical abnormalities.

It is now understood that breath contains thousands of chemical compounds, within both gas and condensate. The chemical patterns of individual breath samples can distinguish between healthy and diseased subjects. The differences seen may relate to a single or multiple volatile molecules of interest, or the concentration of a known compound may relate to disease phenotype. For example, researchers have been able to identify the chemical responsible for the grape-like aroma of *Pseudomonas aeruginosa* (2-aminoacetophenone) in patients infected by this pathogen.

Current technologies

Breath metabolites are prone to high temporal and diurnal variation, and are inherently unstable. This is because they are highly dependent on their chemical characteristics and the sampling method used. Therefore, for the majority of small molecule studies, enhanced data processing methods and standards are required to ensure robust and unbiased analysis.

The interdisciplinary scientific field of metabolomics aims to define the chemical processes within a biological matrix, and thus corresponds well with the requirements of breath analysis studies. To extract information from large and complex data (as in many metabolomic studies), various chemometric tools are employed, ranging from shotgun unsupervised classification techniques, to complex machine-learning algorithms. The ideal experimental and chemometric method will depend on whether the analysis is targeted (known metabolites) or non-targeted (metabolite discovery followed by pathway exploration).

Advances in metabolite analysis instruments have helped develop tools to sample and analyse breath more efficiently. Electronic sensors (commonly called 'e-noses') and ion-mobility-based methods have been adapted from analysing differences in toxic chemicals in the air, to differentiating between breath samples in healthy and disease states. Both have advantages of portability and low cost; however, some require prior training and are limited to binary classification between sample groups.

Mass-spectrometry-based methods further enhance this breath sample differentiation capability by allowing additional separation and selection of metabolites with high sensitivity and specificity. Of these methods, gas

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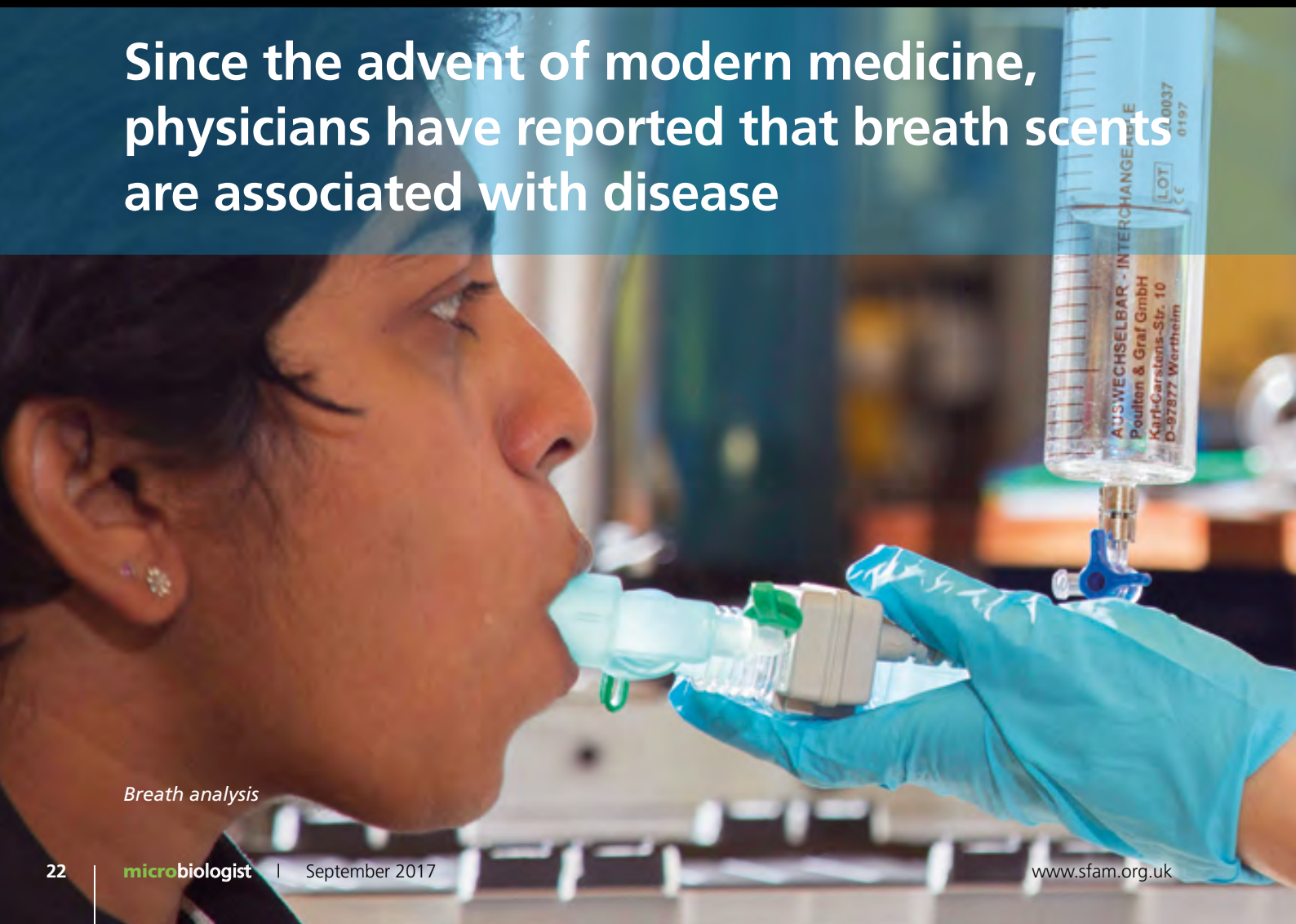

Breath analysis

chromatography-mass spectrometry is by far the most popular as the sample is analysed in the gas phase, but also due to its large compound library and requirement for minimal sample preparation. Other mass-spectrometry-based methods, such as proton transfer reaction-mass spectrometry, and selected ion flow tube-mass spectrometry use chemical ionization for even higher sensitivity to known metabolites, with the latter developed specifically for breath analysis. The downside of mass-spectrometry-based analysis are the high maintenance costs and bulky size, and (to date) most are performed in specialized laboratories and not readily used at the patient's bedside.

Development areas

The complexity of searching for a specific chemical marker in breath is significant given the direct influence of the microbiota and surrounding environment. This is especially important when attributing a metabolite to a specific pathogen, when in fact the immune response may produce the same metabolite. Other influences such as pre-infection underlying disease may alter the dynamics of the lung microbiota, and therefore its metabolic footprint. Some of these may be a reduction in a metabolite from the host's response rather than from the invasive microbe.

Another key topic of ongoing research are methods of breath sampling and analysis. Recently, methodology studies have been reviewed to help researchers evaluate the optimal sampling and analysis methods specific to their own needs.

Although not all studies report the same number and name of metabolites, some unique metabolites across multiple studies have been associated with microbial infection. Furthermore, chemical groups such as branched hydrocarbons have been shown to be released (in both infectious and non-infectious diseases) following an immune response. However, the same metabolites can be found in other diseases, and therefore further validation and larger clinical trials are required.

Breath analysis shows potential for delivering early diagnostic markers of lung infection. The intersection of multiple scientific fields makes this a truly interdisciplinary subject area. Although there are some areas that require further validation and development, the future holds much promise for breath analysis to investigate the mechanism behind respiratory infection pathogenesis and support early diagnosis.

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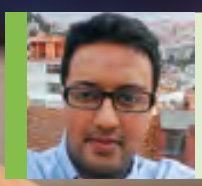

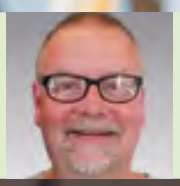

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THE **CHANGING FACE** OF candidosis

Mirror, mirror on the wall, wherein reside fungi amongst us all?

Imagine a face in the mirror. What do you see? Look closely. To the trained eye the cracked red inflamed triangular lesions affecting both corners of the mouth are telltale signs of a condition called angular cheilitis. This represents one of many guises fungi adopt when causing infection in the oral-facial region.

Fungi are everywhere. Normally the eukaryotic single-celled yeast *Candida* spp. enjoys a symbiotic relationship with its host (us) leaving no visual trace of its harmless colonization of the gastrointestinal (GIT) and female reproductive tracts. As the first part of the GIT, the oral cavity harbours one of the most ecologically diverse microbiomes known to man containing a plethora of unique microbial niches such as the teeth and oral mucosa. While the bacterial kingdom predominates, one millilitre of saliva contains more organisms than the UK population, *Candida albicans* is the most common fungal species in the mouth residing primarily on the upper surface of the tongue in approximately four in 10 healthy adults.

Here, the oral manifestations of *Candida* spp. infection will be discussed and two recent discoveries, arguably regarded as game changers in medical mycology, highlighted: (a) Candidalysin, the first C. *albicans* toxin and (b) the emergence of multidrug-resistant *Candida auris.*

Candida auris

Oral candidosis has many guises

The relationship between host and fungi in the oral cavity is a precarious see-saw whereby any imbalance disrupting the status quo allows *Candida* spp. to predominate as an opportunistic pathogen. A variety of host and environmental factors favour this transition including:

1. **Immunosuppression, e.g., malignancy, HIV.**
2. **Diabetes.**
3. **Nutritional deficiencies, e.g., iron and folate.**
4. **Prescription medication, e.g., corticosteroids, antibiotics.**
5. **Cytotoxic drugs, e.g., chemotherapy.**
6. **Radiotherapy.**
7. **Prostheses, e.g., acrylic dentures, orthodontic appliances.**
8. **Dry mouth (xerostomia).**

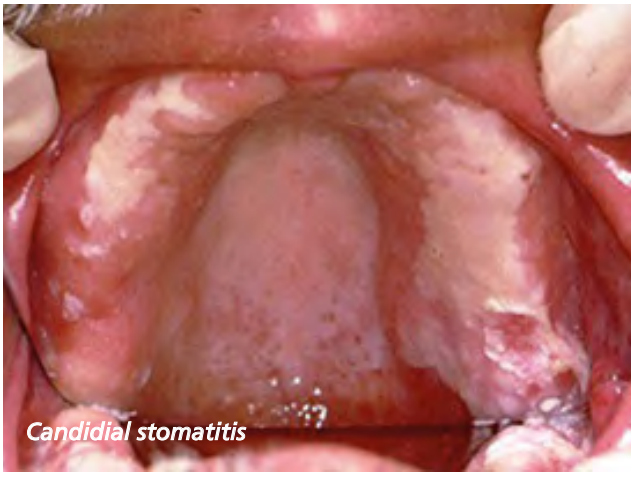
Endogenous infections due to *Candida* spp. generally affect the extremes of age (neonates and the elderly) and reveal much about the immune status of the host, necessitating prompt investigation into the underlying deficiency. A prime example was the prolific rise in oro-pharyngeal candidosis observed during the 1980s amongst young men who it transpired were HIV positive. Prior to the widespread use of antifungals to prevent infections in this group, followed by improved antiretroviral therapy, oro-pharyngeal candidosis was effectively a surrogate marker for the host CD4 count (the white blood cells that the HIV virus infects and kills) and classified as an AIDS-defining illness.

A comprehensive description of the clinical signs, symptoms, diagnosis and patient management of the different forms of oral candidosis is beyond the scope of this feature. Interested readers are advised to consult the further reading list. In brief, the most common clinical manifestation is oral **pseudomembranous** candidosis (US term candidiasis) or thrush as characterized by soft curd-like creamy white plaques in any part of the oral cavity but especially the palate, upper surface of the tongue and inner aspect of the cheeks (buccal mucosa). The plaques can be readily wiped off and consist of fungal hyphal clumps, yeasts, epithelial cells, bacteria and debris. Topical antifungal agents such as nystatin pastilles or miconazole gel plus reversal of the underlying cause is advocated with systemic antifungals such as fluconazole, reserved for more severe cases or debilitated patients.

Denture wearers are particularly predisposed to **erythematous** candidosis (denture stomatitis). Bright red inflamed mucosa is observed corresponding to the acrylic denture load-bearing regions such as the palate. Often the condition resolves solely with scrupulous denture hygiene to physically remove the fungal biofilm. **Angular cheilitis** is another form of candidosis affecting those with dentures, although it also has a strong association with nutritional deficiencies. Worn dentures (sometimes the teeth have virtually disappeared) result in reduced vertical height leading to folds at the corners of the mouth where saliva accumulates causing dryness and irritation. Co-infection with *Staphylococcus aureus* or *Streptococcus* spp. is common particularly in dentate patients. Treatment strategies reflect those for pseudomembranous candidosis.

While the aforementioned forms of candidosis are benign superficial lesions predominantly diagnosed clinically, **chronic hyperplastic** candidosis has more sinister connotations with approximately 5–11% becoming malignant. Unlike other forms of candidosis, the white speckled lesions on the inside of the cheeks

cannot be scraped off and requires a biopsy to confirm the diagnosis alongside specialist referral for management. Other, more rare presentations include oral manifestations of **chronic mucocutaneous** candidosis, a generalized condition affecting the nails, skin and mucous membranes due to a genetic primary immunodeficiency. Finally, as the mouth provides an endogenous reservoir of *Candida* spp., breaches to mucosal barriers, for instance in patients with oral mucositis due to cytotoxic therapy, enables dissemination via the bloodstream (**Candidaemia**) to distant organs. Candidaemia is associated with a mortality rate of approximately 40% and requires prompt initiation of antifungal therapy and further investigations.


Candidial stomatitis

C. albicans molecular weapon fires toxic treats damaging host cells

What triggers a harmless commensal like *C. albicans* to elicit such a spectrum of disease? Blocking this step presents an attractive preventative strategy. While the precise molecular signalling cascade triggering the switch is unresolved, the phenotypic growth transition from ovoid yeast to long, thin branching hyphae has long been heralded a virulence factor of *C. albicans* epithelial invasion. Molecular insights into this engineered weapon that damages host cells are beginning to emerge.

As shown in Figure 1, *C. albicans* adherence protein Hwp1 binds to the oral mucosa and initiates degradation via hydrolytic enzymes. Together, Als3 and Ssa1 mediate further adherence promoting hypha engulfment within an epithelial pocket. This triggers Ece1 to release eight short peptides from the hyphal tip that congregate in the invasion pocket. One of these peptides, the pièce de résistance, Candidalysin, is a cytolytic toxin that attacks the cell membrane causing permeabilization and leakage of cell contents. A cytokine war between the host and pathogen is declared with loss of cellular integrity permitting epithelial invasion of *C. albicans*.

Candida auris is an unwelcome new species causing worldwide havoc

Clearly there is a fine line between winning (health) and losing (disease) the war. To preserve our limited arsenal of antifungal agents, both topical and systemic, a fundamental question is whether the presence of *Candida* spp. from a clinical specimen represents colonization (health) or infection (disease) (Table 1). Prudent antifungal stewardship advocates not treating cases of colonization.

Making this distinction relies on clinical judgement and supported, if appropriate, microbiologically by culture and sensitivity testing from mucosal swabs and/or an oral rinse. The latter is advised if the diagnosis is uncertain, in severely immunosuppressed patients, upon recurrence and failed treatment, and if receiving antifungal prophylaxis. Although *C. albicans* is the most common species causing disease and rates of fluconazole resistance are generally low (< 5%), cases of non-albicans species of Candida, most notably *Candida glabrata*, *Candida tropicalis*, *Candida parapsilosis*, *Candida krusei* and *Candida dublinienesis* are on the rise and resistance is variable.

A new species, *Candida auris*, has recently hit the headlines. First isolated in Japan from the external ear

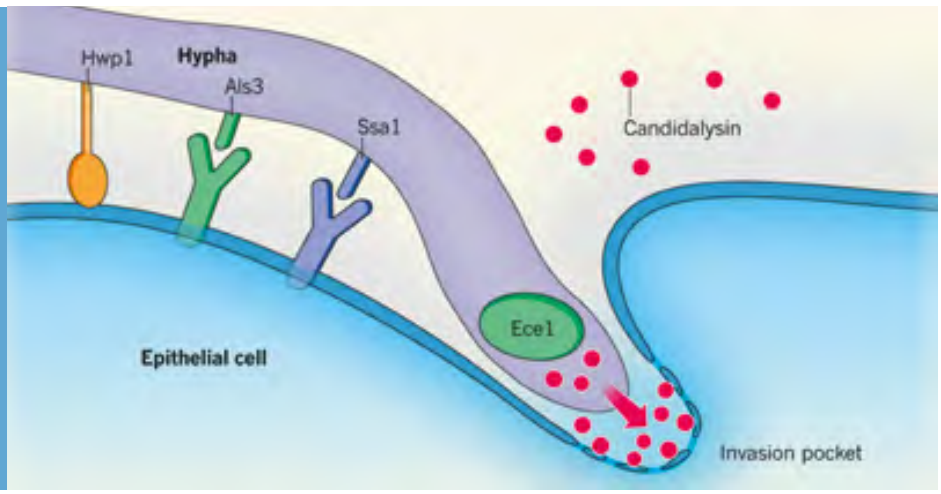


Figure 1 *Candidalysin, the first C. albicans secreted peptide toxin, mediates epithelial cell damage and invasion as part of an orchestrated attack on the host. Hwp1, hyphal wall protein; Als3, agglutin-like sequence protein; Ssa1, heat shock protein 70 family; Ece1, extent of cell elongation 1.*

Figure reprinted by permission from Macmillan Publishers Ltd: Nature (Mitchell, 2016).

Table1: Differentiation between colonization and infection with Candida spp. isolated from the oral-facial region (non-sterile body site)

	Colonization (health)	Infection [1] (disease)
Isolation of *Candida* spp. from a non-sterile site [2]	✔	✔
Clinical evidence of tissue damage & inflammation [3]	✘	✘
Harmless commensal	✔	✘
Treat and/or reverse underlying causative factors	✘	✔

[1] Isolation of *Candida* spp. from a sterile body site, e.g., blood (Candidaemia) is always an infection irrespective of clinical findings. Candidaemia may originate from the oral cavity in severely debilitated patients.
[2] Colonization with *C. auris* has infection control implications and patients must be isolated and decolonization regimes attempted.
[3] Cardinal signs of inflammation, e.g., pain, redness, swelling, heat and/or loss of function.

eight years ago, this species has gained notoriety prompting the Centers for Disease Control (CDC) to issue a Clinical Alert in 2016; an unprecedented act for a fungal pathogen. What makes *C. auris* such a troublemaker?

1. **Multidrug resistant (some strains are resistant to all three major antifungal classes, e.g., polyenes, azoles and echinocandins).**
2. **Difficult to identify in clinical laboratory settings without a high degree of suspicion and access to mass spectrometry or sequencing facilities.**
3. **Affects the most vulnerable and debilitated patients, e.g., intensive care units.**
4. **High rates of colonization with the ability to cause life-threatening infections.**
5. **Associated with person-to-person and environment-to-person spread.**
6. **Difficult to eradicate outbreaks reported in critical care units.**

Clearly such a combination of phenotypic attributes is highly uncharacteristic for a fungus and deeply concerning. This is a rapidly evolving area. Whole genome sequencing of isolates and phylogenetic tree analysis is suggestive of divergence from other Candida genomes. The genetic makeup of *C. auris* is most similar to *Candida lusitaniae* sharing 40% of protein orthologues. Curiously, hyphal growth is minimal *in vitro* so a role for Candidalysin is unlikely, leaving scientists to unearth other potential adhesive and virulence factors.

At present it is unclear if *C. auris* resides in the oral cavity but it is commonly reported in the respiratory tract. Throat swabs are one of the body sites selected to screen for carriage in hospital so it is highly plausible that transient oral colonization is possible together with a theoretical risk of causing localized and systemic disease. Watch this space.

Fungi know neither geographic nor anatomical boundaries when the equilibrium tips. Future faces might have an altogether unrecognizable reflection. Vigilance and concerted efforts by scientists and clinicians are critical to ensure *C. auris* shalt not conquer all.

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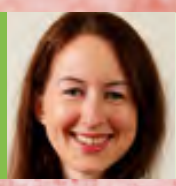

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A nosey

Staphylococcus aureus: at home in our nasal microbiome

The Gram-positive bacterium *Staphylococcus aureus* is one of the most important pathogens worldwide. It has co-evolved with humans, adapting to life in the host and the interventions we have specifically targeted for its eradication. Its versatility as a pathogen is evidenced by the wide spectrum of disease it can cause in the healthy and immunocompromised alike. This derives from its arsenal of virulence determinants and mechanisms to manipulate host immune responses. Potential disease manifestations vary widely from minor skin infections to potentially life-threatening invasive diseases such as pneumonia. However, despite its notoriety as a pathogen, one of its niche environmental habitats is on the human skin as a commensal. Up to 60% of the general population are at least intermittently colonized by the organism, meaning asymptomatic carriage far exceeds the incidence of disease caused by it.

Patterns and determinants of *Staph. aureus* carriage

In humans, the nasal epithelium is regarded as the primary reservoir for *Staph. aureus* carriage. Colonization can occur at any extra-nasal skin site and most commonly the oropharynx, groin and perineum. Studies of symptomless nasal colonization have demonstrated three broad patterns of *Staph. aureus* carriage in the population, which include non-carriers, and intermittent and persistent carriers. In intermittent carriage colonization, episodes last between weeks to months, whilst in persistent carriers it can be years of colonization, usually by the same strain, whilst non-carriers are increasingly viewed as individuals who probably become colonized, but only very transiently, over periods of days to a few weeks.

Evidently there is a complex interplay of organism and host factors accounting for these variable carriage patterns. A number of risk factors are associated with elevated rates of *Staph. aureus* carriage, for instance, the extremities of age where increased rates are found in infants and the elderly population. Co-morbid disease increases rates of colonization in individuals with chronic diseases such as diabetes, HIV, renal failure, obesity or inflammatory skin disease. Environmental factors heavily influence exposure to *Staph. aureus* with overcrowding, hospital inpatient admissions and residency in long-term care facilities, such as nursing homes, being associated with elevated carriage rates. Host genetic makeup must also be contributory and prior evidence has raised the possibility that human leukocyte antigen (HLA) status and glucocorticoid receptor polymorphisms may be associated with increased carriage, however much remains to be understood regarding this.

In humans, the nasal epithelium is regarded as the primary reservoir for *Staph. aureus* carriage

Niche adaptation

The microbiome and its variation between individuals will likely impact carriage status given what we know about co-species antagonism during colonization between *Staphylococcus epidermidis* and *Staph. aureus*

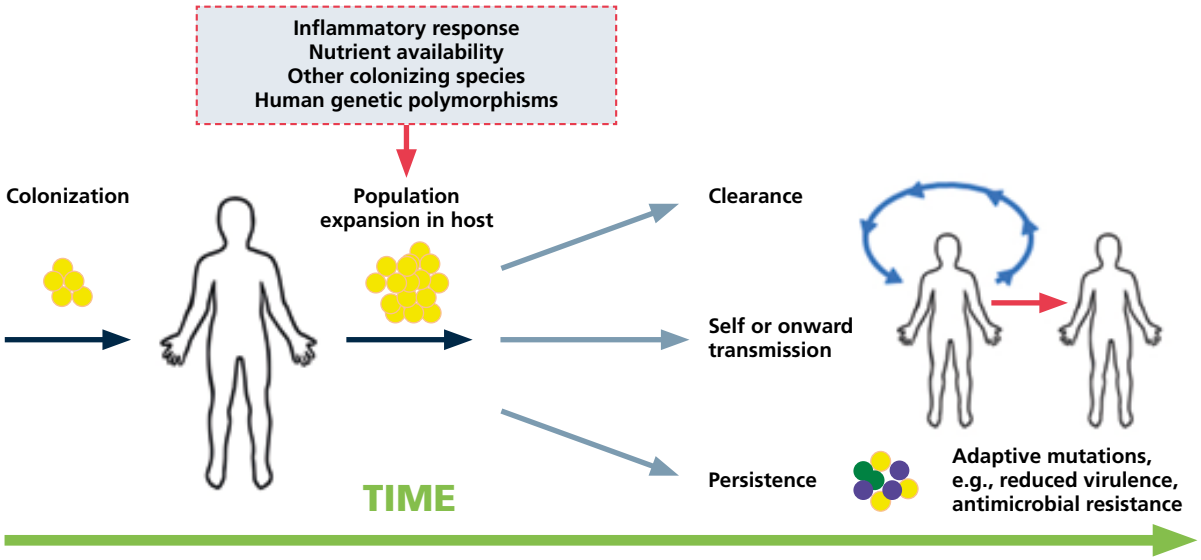


Figure 1 Staphylococcus aureus colonization and its outcomes

Colonization begins with Staph. aureus (yellow circles) being acquired from an external source. The population then expands influenced by factors in the new host (examples are in the perforated box). Potential outcomes then include complete clearance such as in transitory colonization, transmission in the individual which can lead to infections such as impetigo, or transmission to another external source. In individuals with persistent colonization there is growing evidence of adaptive genetic changes occurring in the host that aid persistence of which the most well-recognized examples are down-regulation of virulence and development of antimicrobial resistance (mutations are represented by purple and green circles).

for instance. However, overcoming the other microflora is only one hurdle the organism must face to establish residence on our skin. It must also then evade host clearance which is mediated, for instance, through physical clearance by nasal secretions which effectively wash away *Staph. aureus* present in the nasal cavity. Next is evasion of the host innate immune system, where components such as immunoglobulins IgA and M, and antimicrobial peptides such as human beta defensins target its clearance. Presumably factors such as bacterial colony burden and resistance to these antimicrobial peptides facilitate the organism finally managing to attach to the host epithelium. This process is mediated through attachment via bacterial cell wall anchored (CWA) proteins such as clumping factor B. Many of these CWA proteins have human epidermal keratins such loricrin and keratin 10 as their tissue ligands, exemplifying how uniquely adapted *Staph. aureus* is to life on the human skin.

Nasal carriage and infection

Once colonization is established, there are a number of potential outcomes. It may be transitory and cleared rapidly without any consequence. Alternatively, *Staph. aureus* may become a fixed resident where its inhabitancy can go unnoticed, or go on to be

microbe

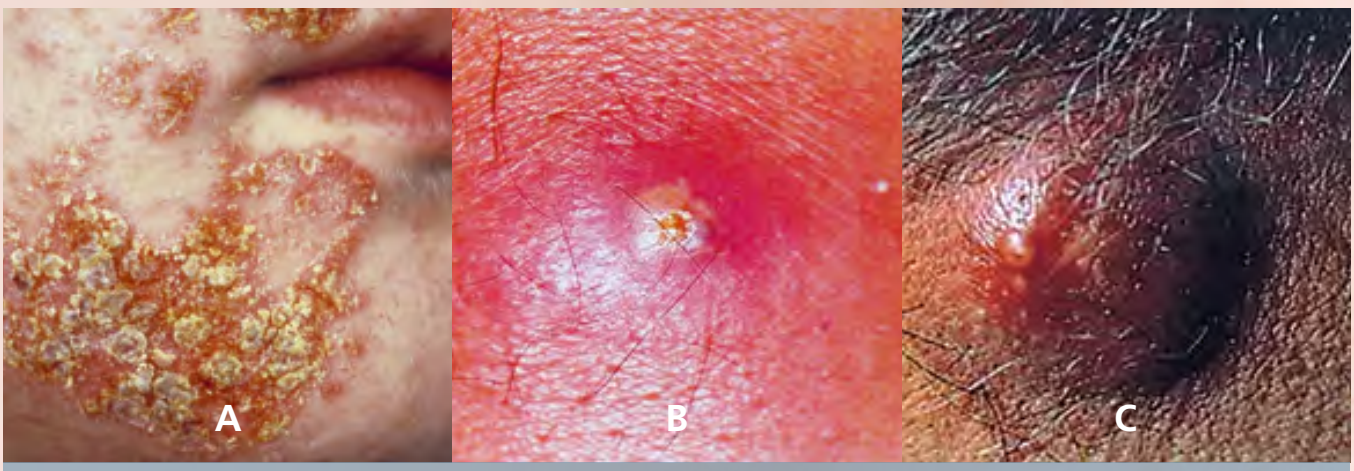


Figure 2 Common skin infections caused by Staph. aureus and associated with nasal carriage

***A**- Impetigo. Characteristic golden crust on face in peri-oral distribution. **B**- Folliculitis. Pus can be seen within a hair follicle and surrounding inflammation causing redness of the skin. **C**- Carbuncle. Multiple hair follicles have become infected and are filled with pus. A cystic type swelling is seen on the surface with multiple areas of pustule formation.*

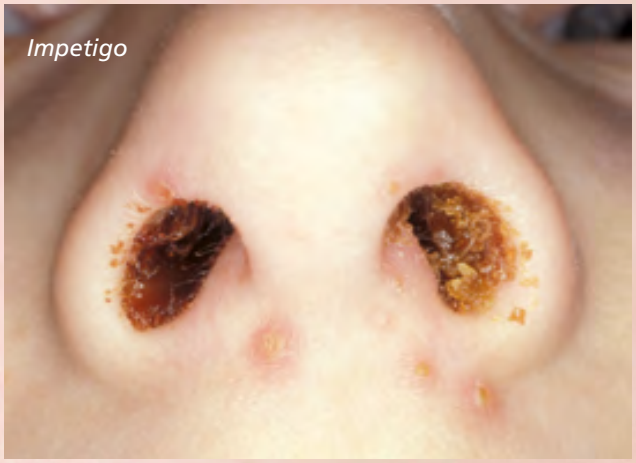
Images courtesy of Dr Shona Ogilvie and Dr Heather Cameron, Department of Dermatology, Ninewells Hospital, Dundee.

problematic in a disease sense (Figure 1). While carriage is considered a risk factor for the development of nosocomial or post-operative infections, the strongest evidence is in its association with localized skin and soft tissue infection. Numerous studies have demonstrated nasal *Staph. aureus* carriage rates of up to 80% in individuals who present with the commonest variants of skin infection including impetigo, folliculitis and carbuncles (Figure 2). This is in comparison to an estimated general population point prevalence carriage rate of 30%. In clinical practice, recurrent bouts of any of these presentations in an individual would raise strong suspicion of a nasal source of the localized disease. Interestingly, recurring boils and folliculitis is an example of where disease phenotype has been shown to correlate with the organism's genotype. Carriage of the Panton-Valentine leucocidin (PVL) genes was initially thought to be responsible for hyper virulence leading to invasive disease, however, both epidemiological and meta-analyses data has instead shown that PVL positivity is actually more frequently associated with folliculitis and other skin infections of milder severity.

A reservoir for trouble?

Molecular epidemiology and candidate gene studies of nasal carriage led to several important advancements in our understanding of *Staph. aureus* as a species. Primarily, it allowed the clonal population structure of *Staph. aureus* to be characterized through a method known as multi-locus sequence typing, whereby sequences of internal fragments of seven housekeeping genes are used to define the strain type (ST) of an isolate, demonstrating the relatively limited number of highly successful *Staph. aureus* lineages globally. However, with the advent of whole genome sequencing it became possible to define the relatedness of global collections of *Staph. aureus* from carriage and disease. This major breakthrough made it possible to define the genome-wide mutation rates meaning that timescales for microevolutionary changes such as the development

The Gram-positive bacterium *Staphylococcus aureus* is one of the most important pathogens worldwide



Impetigo

of resistance could be defined. As a direct consequence, WGS is now routinely used for outbreak investigations. In this scenario, sequences of isolates from individuals thought to have contracted the same *Staph. aureus* strain can be compared at genomic level and linked on the basis of small numbers of single nucleotide polymorphisms within the core genome which differentiate them. This then allows reconstruction of transmission networks and source identification to stop spread in inpatient care settings that in many cases are due to asymptomatic nasal reservoirs in staff and patients.

Sequential sampling of nasal carriage populations in individuals, just as has been used to define carriage status epidemiologically, can be interrogated with WGS and used to study in-host evolution of the pathogen. This approach is increasingly informing us of the adaptive evolution in *Staph. aureus* in individual hosts during carriage, and with potentially major consequences for disease development. For instance, the study by Young *et al*. (2012) demonstrated that over the time course of 15 months nasal colonization, there was a sequential accumulation of mutations in virulence regulatory genes of an individual patient's carriage population. The subsequent outcome of this adaptive down-regulation of virulence was progression to fatal systemic disease. Studies of this type are changing our understanding of this pathogen, and its strategic attempts to maintain survival in our microbiome, and have huge potential to inform us how bacterial pathogens in general contribute to disease causation and persistence.

Notoriety aside, *Staph. aureus* is a normal member of our skin flora. Studying the organism during its nasal carriage provides a unique opportunity to observe and understand its evolution and adaptation to the human body in clinically relevant timescales and with highly translational potential.

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Catriona Harkins
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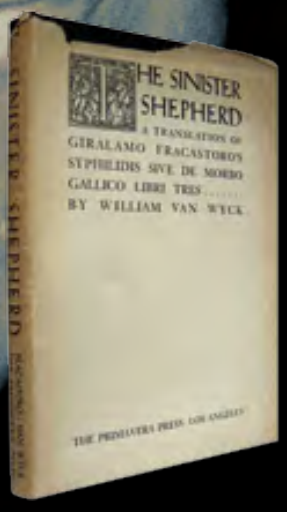
Syphilis AND FACIAL DESTRUCTION

Tertiary syphilis head

'Thus was the shepherd flailed and thus debased.
And after him this malady we call
SYPHILIS, tearing at our city's wall
To bring with it such ruin and such a wrack,
That e'en the king escaped not its attack.'



From **Van Wyck, William**
The Sinister Shepherd: a translation of Girolamo Fracastoro's Syphilidis; sive, De morbo gallico libri tres. Los Angeles, 1934.

From its beginning, syphilis has always been feared by society

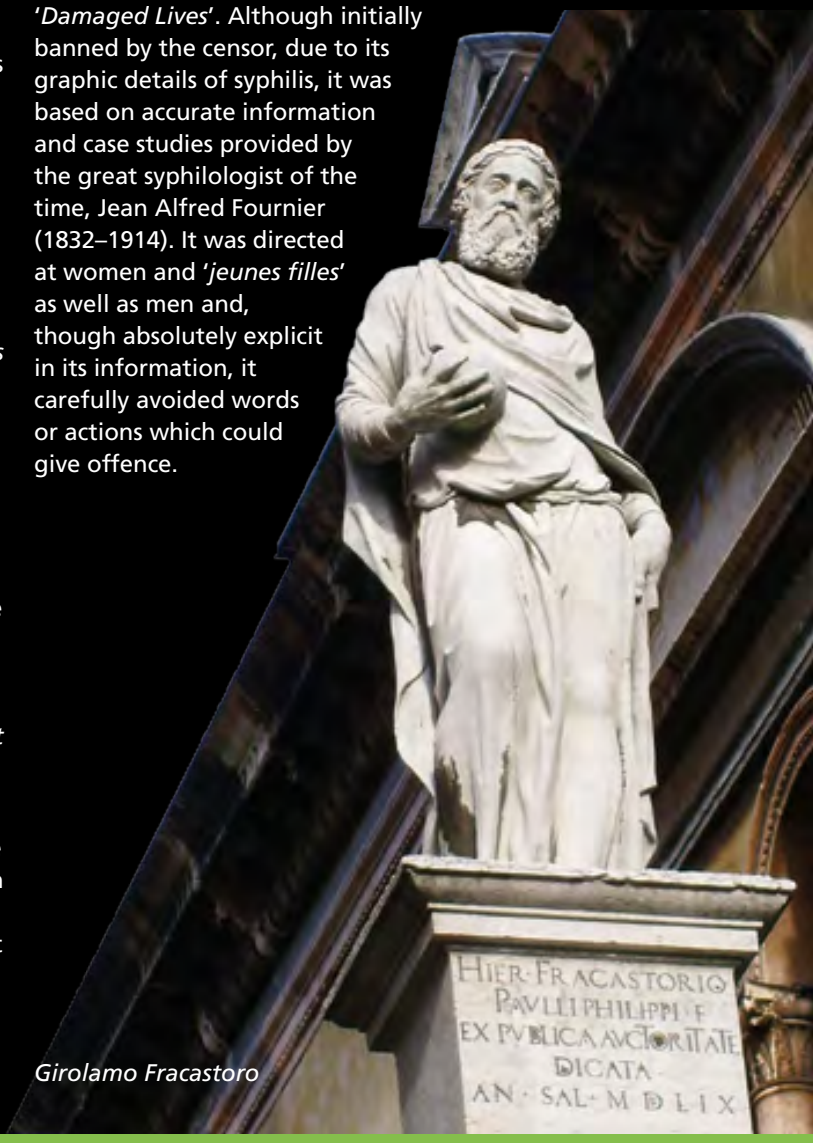
Introduction

Syphilis, the *great pox*, has been the subject of mystery and legend since its recognition as a new disease in 15th century Europe. The disease seemed to be more prevalent in foreign sailors and soldiers, acquired during their frequent sexual encounters with local prostitutes, and this generated a certain xenophobia when describing the disease; the French called it the Spanish disease, the Italians called it the French disease and so on. In Northern India, the Muslims blamed the Hindu and the Hindu blamed the Muslims but, in the end, everyone blamed the Europeans.

Then, in 1530, Girolamo Fracastoro (1478–1553) published a poem that gave the disease its more famous name. Whilst the poem is filled with mythological allusions, it affords a good clinical description of the origin, symptoms and treatment of the disease. The poem has Apollo cursing the people with a monstrous ailment called syphilis to punish a shepherd named Syphilus who had blamed the Sun-god for a terrible drought (*Syphilidis; sive, De morbo gallico libri tres*). Fracastoro also coined the term gumma (Latin; 'gumma' meaning gum or resin), referring to the *pus that escapes from the body and hardens into scabs like resin* that were indicative of the late scirrhous skin lesions. During Charles VII's retreat back to France after the disastrous Battle of Fornova (Italy) in 1495, many of his soldiers were so ill with syphilis they were unable to fight. Once in France, the army was disbanded and the soldiers and their camp followers took the disease with them back to their respective homelands. Many years later, Voltaire (1694–1778) voiced his opinion about the war: *On their flippant way through Italy, the French carelessly picked up Genoa, Naples and syphilis. Then they were thrown out and deprived of Naples and Genoa. But they did not lose everything – syphilis went with them.*

But where did it originate? The theory has always been that Columbus and his sailors brought syphilis to Europe from the New World but skeletons unearthed in London in 2010 provided evidence that syphilis may have existed in the Old World, well before Columbus even set sail for the Americas. A number of these skeletons were found with the characteristic changes of syphilis. Two of the skeletons were radiocarbon dated to 1200–1250, while another five were dated to 1250–1400. Although this has been disputed by other scientists, it seems possible that Columbus actually took syphilis, or its progenitor, to the New World.

From its beginning, syphilis has always been feared by society – the spreading lesions, the pain and disfigurement that the sufferer endures, the severe after-effects of the treatment, and most of all, because it was spread by an inescapable facet of human behaviour, sexual intercourse. Several publications appeared around 1900 which attempted to publicize the dangers of syphilis in society including Brieux's powerful play *Les Avariés* (1901), or '*Damaged Lives*'. Although initially banned by the censor, due to its graphic details of syphilis, it was based on accurate information and case studies provided by the great syphilologist of the time, Jean Alfred Fournier (1832–1914). It was directed at women and '*jeunes filles*' as well as men and, though absolutely explicit in its information, it carefully avoided words or actions which could give offence.



Girolamo Fracastoro

The disease

Syphilis is caused by the spirochaete *Treponema pallidum* subspecies *pallidum*. The signs and symptoms of syphilis vary depending on which of the four stages it presents (primary, secondary, latent or tertiary). The primary stage classically presents with a single chancre (a firm, painless, non-itchy skin ulceration) but there may also be multiple sores. In secondary syphilis, a diffuse rash occurs, which frequently involves the mouth or vagina, the palms of the hands and soles of the feet. This can then be followed by latent syphilis, which can not only last for years but often has little or no symptoms. But it is tertiary, or late, syphilis which occurs in roughly 15–30% of those infected and sometimes as long as 10–20 years after the initial infection, which causes the cavalcade of symptoms including tissue damage, muscle damage, organ damage, coordination problems, paralysis, numbness, gradual blindness, dementia and death.

The classic tertiary skin lesion probably forms as a result of an ineffective delayed-type hypersensitivity (DTH) reaction and its clinical presentation varies according to the level of involvement, which may be hypodermic (syphilitic gumma) or dermo-epidermal (psoriasiform plaques or nodules) and may involve mucocutaneous, cardiac, ophthalmic, neurological or osseous tissues. In addition, there is destruction of tissue secondary to loss of sensory nerve function. The nodular form consists of painless, hardened erythematous nodules, of varying sizes, which may occur on any site on the skin. They may remain isolated or coalesce to form plaques. Multiple nodules may be distributed in an arciform pattern, with a predilection for the face, interscapular areas and extremities. The gummatous form presents itself as firm, painless subcutaneous nodules which later develop ulcerations and drainage of necrotic materials.

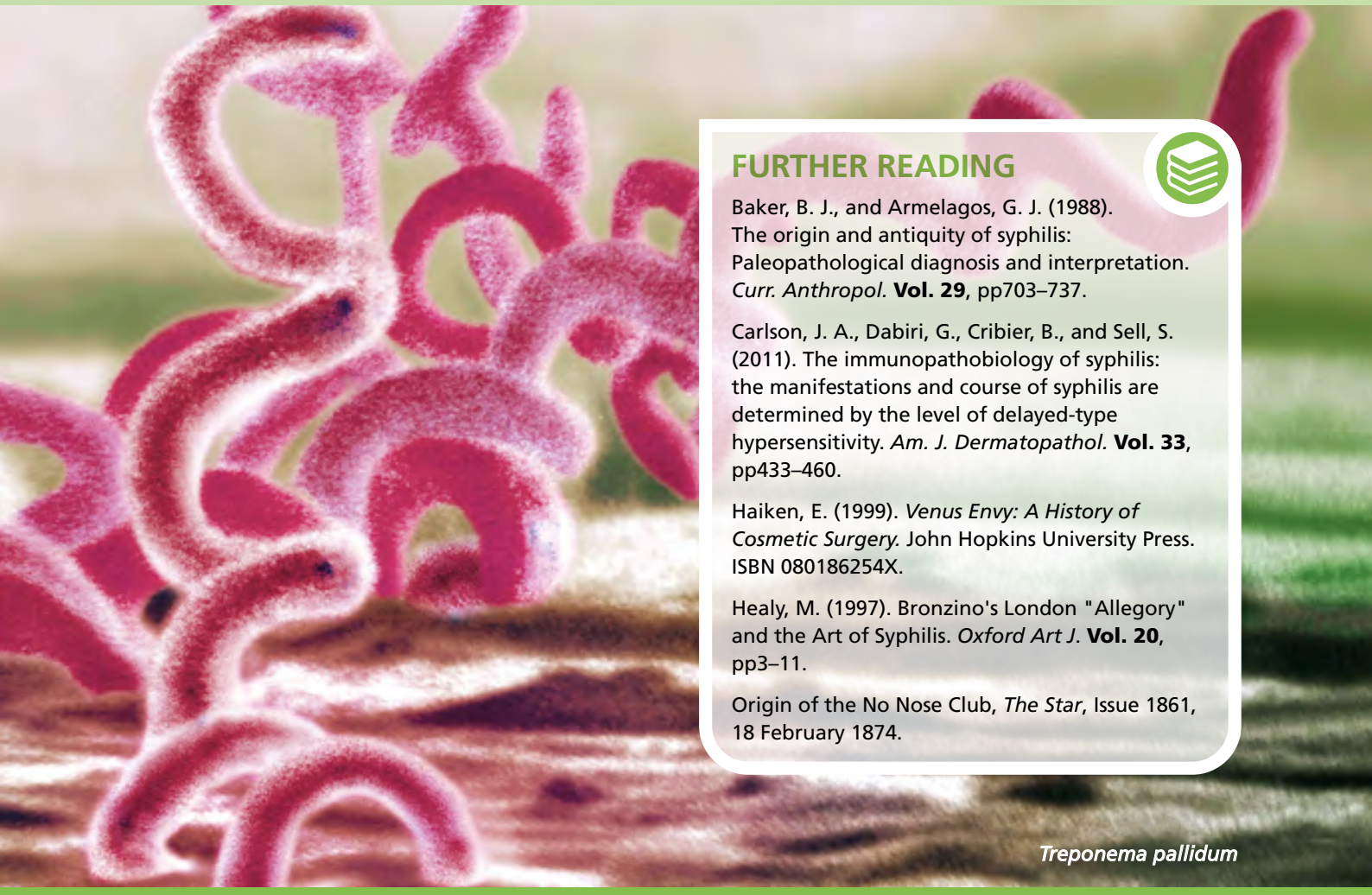
Concealing the scars of syphilis

The facial marks and disfiguration of syphilis have been shown in both art and literature for many years and the earliest known depiction of an individual with syphilis is Albrecht Dürer's (1471–1528) *Man with Pox*, believed to represent a Landsknecht (Northern European mercenary soldier) where the disease is thought to have been caused by astrological interference rather than infection. The infamous Cesare Borgia (1475–1507), is believed to have suffered from syphilis and wore a mask to cover up the disfigurement on his face that came from the disease. He was considered to be the most handsome man of his day so it must have been a bit of a shock when he started showing the telltale symptoms of syphilis.

Other publications show that syphilis was ubiquitous in 18th century London and the characteristic signs of the disease could often be seen, allowing the astute observer to steer clear of infected persons. Blemishes caused by syphilis came to be associated with prostitution and so respectable Georgian women went to great lengths to cover these marks with 'beauty spots' made of fine black velvet, or mouse skin.

One of the most shocking symptoms of advanced syphilis was the gaping hole left in the centre of the face where the disease had eaten away the flesh and cartilage of the nose. The condition, now known as saddle-nose deformity, is caused by the collapse of the nasal bridge and is relatively common, certainly among victims of congenital syphilis. With the outbreak of the syphilis epidemic in 16th century Europe, the syphilitic nose became a mark of shame, a visible sign of the moral and bodily corruption that stigmatized its unfortunate victims. Many Europeans tried to hide their bald spots and sunken, decaying noses with powdered wigs and false noses which became increasingly popular, along with codpieces and merkins.

Some, in desperation, turned to more radical methods for disguising their deformities with a surgery that was already being performed during the Renaissance period in Europe to repair the damage caused by duelling.



Treponema pallidum

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Origin of the No Nose Club, *The Star*, Issue 1861, 18 February 1874.

As you can imagine, two men attacking each other with sharp-bladed weapons was a recipe for removing body parts, including noses. Most plastic surgeons today recognize Italian Gasparo Tagliacozzi (1546–1599) as the father of modern plastic surgery. He used a modification of a method developed by the ayurvedic physician Sushruta (ca. 600 BC), experimenting with the use of pedicles. This involved relocating a section of skin, subcutaneous tissues and vasculature to another area to cover a wound.

Tagliacozzi would take skin grafts from the upper arm and, after several painful procedures, attach the flap onto the nose. The patient's arm would then be held in place using bandages for approximately two weeks while the graft attached itself to the face. Afterwards, the surgeon severed the new 'nose' from the arm and began reshaping and contouring the piece of skin. These surgical innovations promised partial restoration of the nose but, due to the religious zeal of the Counter-Reformation and the concomitant emphasis on the syphilitic nose as a justifiable punishment from God, much of his work was stopped.

Conclusions

Georgian England was renowned for sexual promiscuity and syphilis became as much a part of society as powdered wigs and opium but it had terrible consequences. Before the introduction of antibiotics, the effects of syphilis had a devastating effect on society. Reports seem to suggest that young women who lost their noses were often disowned by their fiancés because it suggested either a venereal or moral disease although it is believed that the more common mode of transmission in the early days may have been non-venereal. The disease was passed by mouth-to-mouth contact as the common method of greeting was not the handshake but a kiss. Tagliacozzi himself wondered if a reconstructed nose was grounds for terminating a marriage arrangement. Still, a young woman with a reconstructed nose was hardly seen as an object of desire. But it shows that the nose job or rhinoplasty is not, as we all think, a modern-day procedure.

Finally, Professor Tagliacozzi provided us with a famous plastic surgery quote that is as true today as it was then:

"We restore, rebuild and make whole those parts which nature hath given, but which fortune has taken away. Not so much that it may delight the eye, but that it might buoy up the spirit and help the mind of the afflicted."

Stephen Mortlock
Nuffield Health

Three Mills. My round?

One hundred years ago, in the autumn of 1917, Bolshevik Red Guards stormed the Tsar's Winter Palace in Petrograd, an event immortalized by the great Russian film director Eisenstein in his film '*October*'.

Not surprisingly, such epoch-defining moments rather overshadowed a more modest outbreak of civil unrest that occurred in England at about the same time and one that is more redolent of an Ealing comedy than an Eisenstein epic.

In an otherwise tranquil Cambridge, the police were called out to defend horse chestnut trees from marauding bands of children who were energetically attacking them to collect horse chestnuts. 'Conkers' had always been subject to limited harvesting for use in contests where, strung on a string, they would be viciously scythed through the air as competitors tried to destroy their opponent's conker (and occasionally their knuckles!). In 1917 though, there was a new impetus to the harvest as conkers had now been identified as an important national resource. Behind this lies a milestone in the history of applied microbiology: acetone butanol fermentation – the first microbiological process to require asepsis on an industrial scale.

London's MICROBIOTA

A series on applied microbiology themes in the capital

From its beginning, the First World War had seen unprecedented demands for cordite, a smokeless propellant for naval guns and other artillery. Acetone was used as a solvent in its manufacture and existing supplies, produced largely by the destructive distillation of wood, were nowhere near sufficient. A fermentation process using potatoes had been developed before the war by a consortium based in Manchester, London and Paris, centred around Strange & Graham, Technical Research Chemists in London's City Road, but it had not proved very successful in practice. Chaim Weizmann, a lecturer at Manchester University, was a member of the consortium but had been sacked in 1912 after disagreements about money and recognition. Following his dismissal, he continued to work on the project independently, going on to isolate the bacterium now known as *Clostridium acetobutylicum*, which could produce acetone reliably and in useful quantities from maize. He offered this to the Government who, in 1915, provided him with pilot facilities to prove the process at Nicholson's Three Mills Gin Distillery on the River Lea in Bow, East London.

Nicholson's started in London during the 18th century 'gin craze' and produced the popular Lamplighter London Gin at distilleries in Clerkenwell and at Three Mills. The company enjoyed impeccable establishment connections through parliament and cricket. William Nicholson, the company chairman, was a Liberal Member of Parliament for Petersfield and his father, also an MP, had been an enthusiastic cricketer – so much so that he had loaned the Marylebone Cricket Club (MCC) the money to buy Lord's cricket ground in London. One reward for this generosity was that the MCC adopted Nicholson's colours – bright yellow and red – as their own. To this day, the same colours adorn the club's famously migraine-inducing tie in honour of Nicholson.

Successful gin production does not require strict asepsis and the facilities available at Bow meant that problems of contamination bedevilled acetone production there. Nonetheless, sufficient promise was shown for it to be rolled out to a distillery in Scotland, an existing (previously unsuccessful) acetone factory in King's Lynn and a large, newly built plant at the Admiralty cordite factory in Dorset. It was further proposed to take over all UK distilleries for this purpose: a plan that was greeted with some dismay when Lloyd George announced it to the distillers at a meeting in February 1916.

In the event, to the relief of the distillers, this did not happen since it was recognized as more cost-effective to use valuable shipping to import acetone produced where maize was grown in North America rather than maize to produce acetone locally. The process did however continue on a quite substantial scale at the four existing sites in the UK so there was considerable interest in reducing its reliance on imported maize.

Conker boys in Sussex

The possibility of using horse chestnuts was first mooted in April 1917 and Weizmann's advice sought. He was no longer working at Three Mills but had moved across London to laboratories, first at the Lister Institute in Chelsea and then across the river at Point Pleasant, Wandsworth. Test results showed horse chestnuts could be used, although a pre-treatment was required to reduce levels of an inhibitory glycoside, aesculin, and the fermentation sometimes foamed excessively.

Following this success, a national horse chestnut collection scheme was devised and outlined in a Government circular to local education authorities issued in August. It emphasized the value of horse chestnuts as an alternative to maize in 'certain industrial processes which are essential to the prosecution of the war'. Under the scheme, horse chestnuts were to be left at local centres from where collection would be arranged.

Seizing an opportunity to support the war effort, the patriotic zeal of youth knew no bounds and elderly citizens were distraught to see their trees under enthusiastic and noisy assault by unruly bands of small people, occasionally hotly pursued by breathless policemen. Despite this, more than 2,000 tons of horse chestnuts were collected, though failings in organization meant that many tons were also left rotting at collection points. The scheme was considered sufficiently successful for discussions to be held on improvements for the following year though, in the event, it was not repeated and the war ended in November 1918.

With peace, the distillery reverted to its former role until it was bombed during the Second World War – an event which occasioned one of the many tales of selfless bravery characteristic of the blitz when unnamed local heroes risked their all to dive into the River Lea and save six barrels of spirits from being lost. Today, though no longer a distillery, several of the original buildings survive as part of London's largest film and television studios: 3 Mills Studios.

Martin Adams
SfAM *President 2011–2014*

ANTIMICROBIAL RESISTANCE
Meeting the Challenge

Charles Darwin House | 12 Roger Street | London | WC1N 2JU

Antimicrobial resistance (AMR) is one of the most important international issues for human and animal health and the global spread of AMR threatens to negate cures for infectious disease that began with the introduction of penicillin. Systematic misuse and overuse of antibiotics in human medicine and animal husbandry have put every individual at risk. The Society for Applied Microbiology joins the Royal Society of Chemistry and the Academy of Pharmaceutical Sciences in responding to the global challenge to help tackle the AMR crisis.

This two-day conference will present our current understanding of AMR, through keynote presentations, case studies, expert opinion and panel discussions. We invite you to join in the AMR debate to help find solutions to this important challenge. **DAY 1** will concentrate on areas spanning novel therapeutics, drug discovery and human health, whereas **DAY 2** will concentrate on issues related to AMR in wastewater treatment. Therefore, the conference is aimed at a wide range of professionals, including clinical, biomedical, veterinary, pharmaceutical, chemical, environmental and wastewater experts.

DAY 1: 23 November 2017
AMR: Novel Therapeutics and Drug Discovery *(in conjunction with the Academy of Pharmaceutical Sciences)*

DAY 2: 24 November 2017
Antimicrobial Resistance in Wastewater *(in conjunction with the Royal Society of Chemistry)*

Fees before 01 November 2017
(includes £60 early-bird discount):

ECS/Life Member	£80
Member	£110
Non-Member	£225

The conference will also offer a light lunch and refreshments for all participants and attendees. Please help us ensure the event's success by registering as soon as possible.

member.sfam.org.uk/SfAM/Events

*Sf*AM ENVIRONMENTAL MICROBIOLOGY Lecture 2017

Vaccines for a 21st century society Professor Rino Rappuoli

6.30pm | 13 October 2017 | One Great George Street | London

The EMI lecture 2017 will be held on 13 October 2017 at One Great George Street, and will be presented by Professor Rappuoli, Chief Scientist & Head of External Research and Development (R&D) at GlaxoSmithKline (GSK) Vaccines.

He is known globally for his work in vaccines and immunology and co-founded the field of cellular microbiology, a discipline combining cell biology and microbiology. He pioneered the genomic approach to vaccine development known as reverse vaccinology.

Professor Rappuoli led Chiron Corporation's development of adjuvanted influenza vaccines, MENJUGATE(R) conjugate vaccine against meningococcal-C disease and the first recombinant bacterial vaccine against pertussis. Currently, he is actively involved in the research and development of further vaccines against meningococcal disease and avian and pandemic influenza.

Other major achievements include the development of CRM197 used in *Haemophilus influenzae*, *Neisseria meningitidis* and pneumococcus vaccines; an acellular pertussis vaccine containing a genetically detoxified pertussis toxin; the first conjugate vaccines against meningococcus; MF59 adjuvant for influenza and the meningococcus B genome-derived vaccine.

During his career, he has introduced several novel scientific concepts: genetic detoxification in 1987, cellular microbiology in 1996, reverse vaccinology in 2000 and the pan-genome in 2005.

Register at sfam.org.uk

The timing of the lecture this year enables it to become part of the Royal Society of Biology's 'Biology Week'.

This is a FREE event for all Members of the Society for Applied Microbiology and selected guests. As the EMI lecture is a popular event and places are limited, we urge Members to book early.

communications@sfam.org.uk

An interview with Professor Koen Venema

Associate Professor
Maastricht University, The Netherlands

Editor-in-Chief
Beneficial Microbes

Professor Koen Venema

Stewart Cumiskey
Society for Applied Microbiology

The Society for Applied Microbiology welcomed Professor Koen Venema as the *Journal of Applied Microbiology* (JAM) lecturer at our Annual Conference in Gateshead in July.

Venema's work focuses on beneficial microbes and how best to harness their potential. He's an expert in using the dynamic, computer-controlled *in vitro* models of the gastrointestinal tract (developed by TNO, and nick-named TIM). We spoke to him about his work and the challenges of upscaling lab work to commercial viability.

What is the main focus of your work at Beneficial Microbes?

The gut microbiota and its role in health and disease; and how to modify that microbiota with prebiotics and probiotics.

How would you define the difference between the two?

Probiotics are live organisms that are present in our food. Prebiotics are substrates that can be used by microorganisms that already live inside us. The definition of these components in our food is that they should actually stimulate our health. Therefore, not all microbes that we ingest are considered probiotics – and not all components could be considered prebiotics.

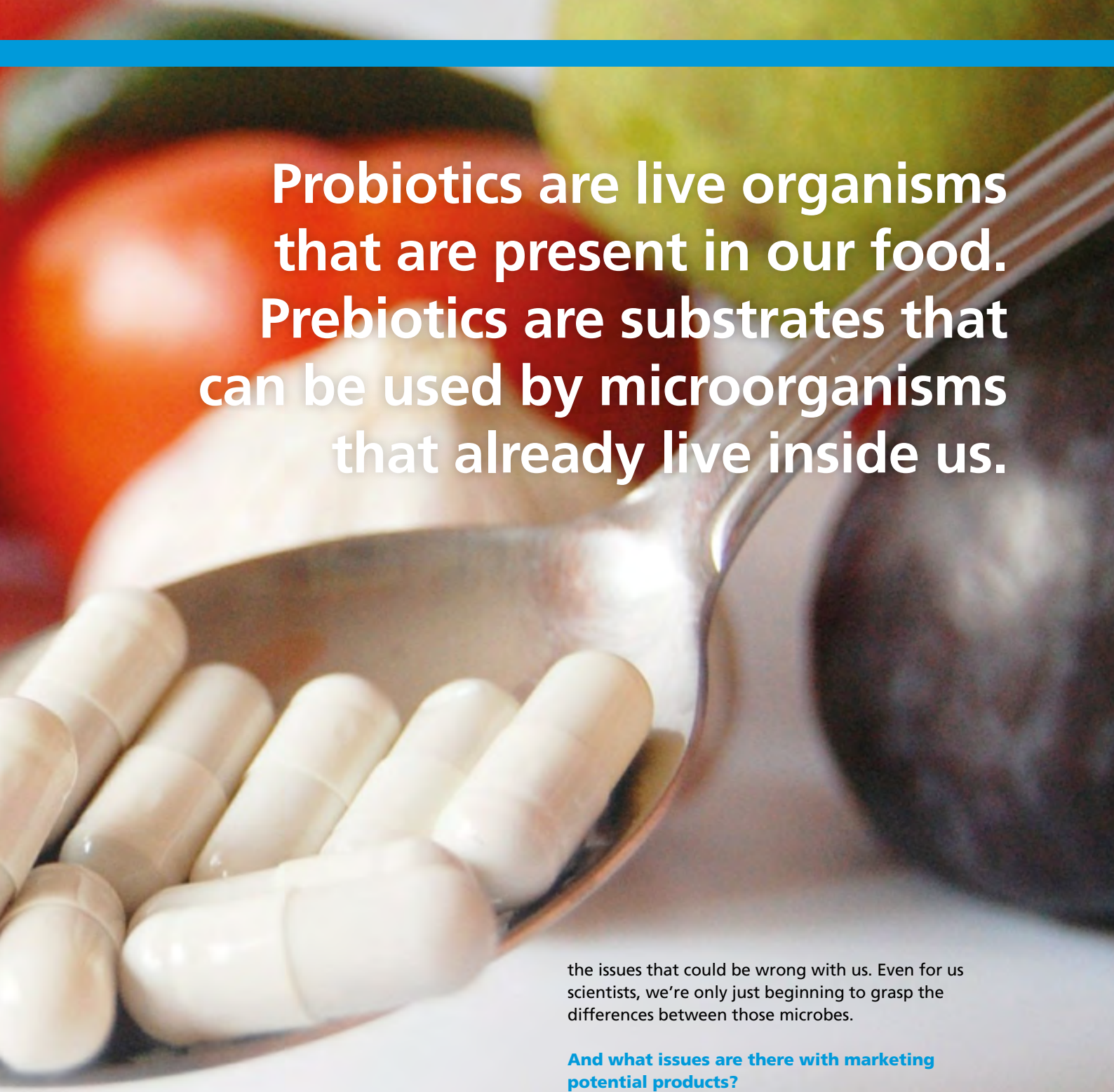
TIM system gut model

Why is this area of research so important?

The gut microbiota can be involved with anything that can be wrong with us, ranging from the gut itself, inflammation etc., but also distant sites of the body, like allergies of the skin and lungs. Gut microbiota are even believed to be involved in brain development and cognition, and obesity, which also seems to be a personal problem, which is why I like to study it as well!

Is this industry experiencing a boom due to public interest?

The area is still in its infancy, but there are some promising results with all kinds of dietary components that actually influence the composition and activity of the gut microbiota. These prebiotics actually stimulate healthy, beneficial microbes at the expense of



Probiotics are live organisms that are present in our food. Prebiotics are substrates that can be used by microorganisms that already live inside us.

pathogenic ones. They make these microorganism-produced components that we are able to absorb and are healthy for us.

Is it difficult to produce satisfactory evidence?

We are studying this in a sophisticated *in vitro* model that mimics the gastrointestinal tract. Due to these *in vitro* studies we hope to be able to find components that can be used later on in food products, commercially.

The problem is that these living microorganisms, what we call probiotics, are not all the same. Some probiotics are good for say, constipation. Another one may be good if you have a cold. If consumers don't know which ones to take, then it becomes difficult to correct the issues that could be wrong with us. Even for us scientists, we're only just beginning to grasp the differences between those microbes.

And what issues are there with marketing potential products?

Since 2013, the European Food Safety Authority won't allow use of the phrase 'probiotics' on products and commercial websites. The EFSA isn't convinced that the current data and research is of sufficient quality to prove that certain microorganisms have a health benefit. There are also many factors (other than poor study design) that may explain variable outcomes in human probiotic studies. Inconsistencies can arise from the strain and the dose used, the duration of providing the probiotic and the method of administration (yoghurt drink, tablet, capsule, powder).

Despite such challenges, validated *in vitro* models of the gastrointestinal tract are great tools to understand the effects of pro- and prebiotics on gut microbiota composition and activity and may predict health outcomes in humans, despite its inherent limitations.

The 86th Annual General Meeting of the Society for Applied Microbiology was held on Wednesday 5 July 2017 at 17.15 in the BALTIC Centre for Contemporary Art, Gateshead, UK

Present:

58 Members attended the AGM. This included:

President, Christine Dodd (CD)
Vice President, Mark Fielder (MF)
General Secretary, Clare Taylor (CT)
Treasurer, Phillip Wheat (PW)
Meeting Secretary, Ian Feavers (IF)

In attendance:

Chief Executive, Lucy Harper (LH)
Paul Sainsbury (PS)
Laura Lincoln (LL)
Christopher Brown (CB)

1 Apologies for absence

None

2 85th Annual General Meeting

The minutes of the 85th Annual General Meeting held in Edinburgh in 2016 were published in the September 2016 issue of *Microbiologist*. They were approved and accepted by those present.

Proposed: Andy Sails
Seconded: Mark Fielder

3 Matters arising from the previous minutes

None.

4 Report of the Trustees of the Society 2016

The President noted the successful objectives and activities of the Society during 2016, particularly with respect to the success of the journals and thanked both the publishers and respective Editorial Boards. CD highlighted the successful changes to membership categories that has seen the introduction of affordable International Memberships for those Members who reside in lower- and middle-income countries. CD said she was also delighted to receive letters of thanks from those Members who had been awarded Life Memberships.

Also noted was the increased content in the *Microbiologist* magazine that has continued to improve over the year and remained a powerful tool for communicating applied microbiology to the membership and wider audiences. S*f*AM's presence on social media remained engaging, current, topical and a vital way to communicate with today's audience.

CD thanked Paul Sainsbury and his team.

86th S*f*AM **AGM**

The General Secretary gave a summary of the Society's achievements and performance in 2016 communications and public engagement highlighting the key successes of the social media channels and the Society's journals.

CT announced that the paying membership of the Society is at record levels in line with the key areas of the organizational strategy and that it was good to see a very international audience present at the Annual Conference.

CT then praised the continuing dedication given by Members of the SfAM ECS Committee and noted the increasing success of their activities is evident by the introduction of the ECS and ECS Undergraduate categories of membership.

The Treasurer gave a brief financial review, reporting that the Society's value has continued to remain healthy and that net assets now stand at £883554. PW was proud to report that £1.2M worth of Society income for 2016 came from journals and other publications and offered a personal thank you to Jean-Yves Maillard and Arthur Gilmore for their continuing hard work as respective Editors of *Letters in Applied Microbiology* and *Journal of Applied Microbiology*.

PW said the Society continues to be prudent and strives to offer the best possible services it can to all Members.

LH reported on the structure and governance of the Society noting the move from Bedford to Charles Darwin House in London had been a success and welcomed new members of staff Tina Sellwood, Stewart Cumiskey, Christopher Brown, Rosie Stevens and, although not a permanent staff member until 2017, Laura Lincoln.

The Meetings Secretary gave a summary of activities for the year and gave special thanks to new Events and Projects Manager, Laura Lincoln. IF also thanked Margaret McFall-Ngai for giving the *Environmental Microbiology* Lecture and Max Dow for giving the *Journal of Applied Microbiology* Lecture.

IF then looked forward to future planned activities for the Society, stating that the Society will be undergoing a strategy review during 2017 and that actions from the grants and membership benefits reviews will also be implemented. He also noted that the introduction of ECS Undergraduate and Fellowship membership categories illustrate the way in which the Society supports its Members throughout their career.

IF thanked the office team for their continuing hard work and dedication, emphasizing the genuine teamwork that is now clearly evident.

5 Adoption of the Annual Report 2016

Copies of the Annual Report of the Society for 2016 had been distributed previously.

Proposed: Basil Jarvis
Seconded: Jean-Yves Maillard

6 Election of new Members (including honorary Members), deaths and resignations

A list of the names of applicants for membership and a list of deaths has appeared in the *Microbiologist* throughout 2016. The Society also holds a summary list of new Members and resignations throughout the previous year.

CD gave special mention to the sad passing of Professor Dorothy Jones who was President of the Society from 1989–1991.

7 Nomination and election of the President, Mark Fielder

CD announced she had come to the end of her term as President and would step down. Professor Mark Fielder was announced as the new President.

8 Any other businesss

There was none.

The meeting concluded at 18.00.

Passion, joy, chaos: an extended walkabout among microbial light and dark matter

Professor Dr Kenneth N. Timmis[1] *Technical University of Braunschweig, Germany.*
Editor-in-Chief of Microbial Biotechnology, Environmental Microbiology & Environmental Microbiology Reports.

Introduction

My mother exhibited an endless curiosity about everything, especially nature, was a compulsive reader and, through involving me in everything she did, bestowed upon me a serious curiosity and an academic bent, direction biology. My father was sharp but less wide-ranging and, according to some who should know, taught me not to suffer fools. In the sixth form, I became fascinated by microbiology. The careers officer tried to persuade me that there were no sensible career paths for biologists, so to aim for something else. Thinking them a miserable creature, I struggled on and just managed to get onto the Microbiology degree course at Bristol, and subsequently stayed for a PhD. After that, it was a wonderful merry-go-round of postdoc positions – at the Ruhr-University Bochum, Yale (oh: the seafood!), Stanford (oh: the afternoon concerts/ballet/symphony/opera, the National Parks, the weather), and the Max Planck Institute for Molecular Genetics in West Berlin, as head of an independent research group. As I approached the programmed end of this post, my partner signalled that playtime should eventually morph into a real job. So, when offered a professorship in the University of Geneva Medical Faculty, I accepted the need to settle down. After a short period of nest-building, James put in a surprise appearance, so we settled down even more. Except that seven years later, I accepted an impossible-to-refuse joint appointment as Head of the Division of Microbiology at the then GBF (German Research Centre for Biotechnology) and Professor of Microbiology at the TU Braunschweig, where I stayed until retirement in 2011.

Materials and Methods

Protein purification and mode-of-action kits (Bristol), gene cloning kit (Stanford), electron microscopy kit (Stanford and GBF), genomics kit (MPI), microbial pathogenesis factor characterization kit (Geneva and GBF), metabolic design kit (Geneva and University of Stuttgart), marine research vessels and infrastructure (University of Milan), salt and water kit (University of Essex), PCR kit and phyllosphere resources (Universitat de les Illes Balears), publishing kit (ASM and Blackwell/Wiley) and recruitment kit (mostly Iberia).

Results and Discussion

The trajectory of my research interests was already programmed during my undergraduate studies by wonderful, stimulating teachers, especially Anna Mayr-Harting, who brought the major epidemics of Europe to life, and George Ware, who taught environmental microbiology as though it were an electrical circuit; both thinking and acting outside the box. My lifelong research programme has thus been a duo of microbial pathogenesis and environmental microbiology, subsequently flowing together in microbial ecology. Since my goal was to establish causalities and understand underlying mechanisms, I needed to acquire skills in the dark arts of microbial genetics. These were successively absorbed from Uli Winkler in Bochum, with *Serratia* and *E. coli* as models, Don Marvin at Yale with fd phage, and especially Stan Cohen at Stanford, studying plasmid replication with the incredible new toolbox of genetic engineering. Molecular genetics is

the thread throughout all my work, the overarching goal of which has been the understanding of complex microbial processes and interactions, and its exploitation to develop biotechnological applications. Science is the most fun and intellectually rewarding calling, at least for those doing it (*shall I keep your dinner warm or would you like it next week?*), especially when those serendipitous surprises float in.

Editing journals has been another fun component of my academic activities. After a 10-year apprenticeship with the *Journal of Bacteriology*, I launched *Environmental Microbiology* with Dave Stahl, and *Microbial Biotechnology* with Juan Luis, Willem de Vos, Willy Verstraete and Marty Rosenberg. With these amazing people, and Joan as administrator, the journals have flourished and, I hope, provide stimulation and inspiration to microbial ecologists and biotechnologists alike.

In retirement, I stay connected via the journals, S*f*AM meetings, good friends from the group and, in particular, our son James, who is studying health policy and with whom I discuss incessantly and sometimes write on new topics. It has been, and continues to be, an amazing walkabout.

Acknowledgements

I take great pleasure in expressing gratitude to my mentors in life and science: my mother, Rose (for giving me life and that unique relationship that exists between mothers and sons, and so much more; *oh: not another treacle tart!*); my partner of almost 60 years, Joan (for accepting me into her life, her unbelievable love and support, and the incredible gift of our son; *men are a waste of space, fortunately you don't take up too much*); our son, James (*you'd look better with a beard*); Felipe, a wonderful friend who taught me many things, especially about South America, and introduced me to Latin literature (*it amazes me how Joan could stand you for all these years*); Stan, who taught me to cut to the chase (*take the cherries from the top and leave the cake for others*) and, along with a weird but exceptional locum history teacher at school, how to write; Shige Harayama (*the best cherries are inside the cake*); Gabriella Molinari (*sorry: I didn't realise that the reviewer decline button was not supposed to be clicked!*); Isabel Andres, my first postdoc (*bloody hell!*); Victor (*Joan makes the best ever quiche*); Juan Luis (*if you* (England) *pipe us water, we will return it as wine*); Balbina Nogales (*here comes Ken - chaos incarnate*); Singh (*never leave a bottle half-empty: it will continue to tempt you*); Misha (*never leave a bottle half-full: someone else will find it*); Terry (*salt is all*); John (*water is all; chaos reigns*); Don Marvin (*the structure explains function*); Ed DeLong (*the function explains the structure* (community); Ulrich Gosewinkel (formerly Uli Karlson: *if you want to be taken seriously as head of the Division, you need to be able to use a computer: I'll order you a Mac – it's a simple computer for idiots*); and to all the wonderful Editors of *Environmental Microbiology* and *Microbial Biotechnology*. Most importantly, I thank the many people of the group, especially the Spanish, who not only contributed outstanding science but also gifted me their precious friendship. And I hope they will forgive me for the artistic licence I have allowed myself in composing this piece.

Ken Timmis
Chief Editor, Environmental Microbiology, Environmental Microbiology Reports and Microbial Biotechnology

Journal**WATCH**

Highlights and featured articles from the *Sf*AM journals

Environmental Microbiology

www.env-micro.com

Air pollution alters *Staphylococcus aureus* and *Streptococcus pneumoniae* biofilms, antibiotic tolerance and colonization

Shane J.K. Hussey, Joanne Purves, Natalie Allcock, Vitor E. Fernandes, Paul S. Monks, Julian M. Ketley, Peter W. Andrew, Julie A. Morrissey

This study highlights that air pollution has a significant effect on bacteria that has been largely overlooked. Consequently these findings have important implications concerning the impact of air pollution on human health and bacterial ecosystems worldwide.

Air pollution is the world's largest single environmental health risk (WHO). Particulate matter such as black carbon is one of the main components of air pollution. The effects of particulate matter on human health are well established; however, the effects on bacteria, organisms central to ecosystems in humans and in the natural environment, are poorly understood. The authors report here for the first time that black carbon drastically changes the development of bacterial biofilms, key aspects of bacterial colonization and survival. Their data show that exposure to black carbon induces structural, compositional and functional changes in the biofilms of both *Staph. pneumoniae* and *Staph. aureus*. Importantly, the tolerance of the biofilms to multiple antibiotics and proteolytic degradation is significantly affected. Additionally, their results show that black carbon impacts bacterial colonization *in vivo*. In a mouse nasopharyngeal colonization model, black carbon caused *Staph. pneumoniae* to spread from the nasopharynx to the lungs, which is essential for subsequent infection.

http://onlinelibrary.wiley.com/doi/10.1111/1462-2920.13686/full

Meta-analysis of the human gut microbiome from urbanized and pre-agricultural populations

Leonardo Mancabelli, Christian Milani, Gabriele Andrea Lugli, Francesca Turroni, Chiara Ferrario, Douwe van Sinderen, Marco Ventura

Metagenomic studies of the human gut microbiome have only recently begun to explore the differences in taxonomic composition between subjects from diverse geographical origins. Here, the authors compared taxonomy, resistome and functional metabolic properties of publicly available shotgun data sets of human faecal samples collected from different geographical regions (Europe, North America, Asia and Oceania).

Such data sets encompassed gut microbiota information corresponding to 13 developed/industrialized societies, as well as two traditional hunter-gatherer, pre-agricultural communities (Tanzanian and Peruvian individuals). Assessment of the retrieved taxonomic profiles allowed the most updated reconstruction of the global core-microbiome as based on currently available data, as well as the identification and targeted genome reconstruction of bacterial taxa that appear to have been lost and/or acquired during urbanization/industrialization. Functional characterization of these metagenomic datasets indicates that the urbanization/industrialization process which occurred in recent human history has shaped the gut microbiota through the acquisition and/or loss of specific gut microbes, thereby potentially impacting on the overall functionality of the gut microbiome.

http://onlinelibrary.wiley.com/doi/10.1111/1462-2920.13692/full

Environmental Microbiology Reports

www.env-micro-reports.com

Influence of oxygen availability on the activities of ammonia-oxidizing archaea

Wei Qin, Kelley A. Meinhardt, James W. Moffett, Allan H. Devol, E. Virginia Armbrust, Anitra E. Ingalls, David A. Stahl

Recent studies point to the importance of oxygen (O_2) in controlling the distribution and activity of marine ammonia-oxidizing archaea (AOA), one of the most abundant prokaryotes in the ocean.

The AOA are associated with regions of low O_2 tension in oceanic oxygen minimum zones (OMZs), and O_2 availability is suggested to influence their production of the ozone-depleting greenhouse gas nitrous oxide (N_2O). The authors show that marine AOA available in pure culture sustain high ammonia oxidation activity at low μM O_2 concentrations, characteristic of suboxic regions of OMZs (<10 μM O_2) and that atmospheric concentrations of O_2 may inhibit the growth of some environmental populations. They quantify the increasing N_2O production by marine AOA with decreasing O_2 tensions, consistent with the plausibility of an AOA contribution to the accumulation of N_2O at the oxic-anoxic redox boundaries of OMZs. Variable sensitivity to peroxide also suggests that endogenous or exogenous reactive oxygen species are of importance in determining the environmental distribution of some populations.

http://onlinelibrary.wiley.com/doi/10.1111/1758-2229.12525/full

Hydrogen or formate: alternative key players in methanogenic degradation

Bernhard Schink, Dominik Montag, Anja Keller, Nicolai Müller

Hydrogen and formate are important electron carriers in methanogenic degradation in anoxic environments such as sediments, sewage sludge digesters and biogas reactors. Especially in the terminal steps of methanogenesis, they determine the energy budgets of secondary (syntrophically) fermenting bacteria and their methanogenic partners.

The literature provides considerable data on hydrogen pool sizes in such habitats, but little data exist for formate concentrations due to technical difficulties in formate determination at low concentration. Recent evidence from biochemical and molecular biological studies indicates that several secondary fermenters can use both hydrogen and formate for electron release, and may do so even simultaneously. Numerous strictly anaerobic bacteria contain enzymes which equilibrate hydrogen and formate pools to energetically equal values, and recent measurements in sewage digesters and biogas reactors indicate that – beyond occasional fluctuations – the pool sizes of hydrogen and formate are indeed energetically nearly equivalent. Nonetheless, a thermophilic archaeon from a sub-marine hydrothermal vent, *Thermococcus onnurineus*, can obtain ATP from the conversion of formate to hydrogen plus bicarbonate at 80°C, indicating that at least in this extreme environment the pools of formate and hydrogen are likely to be sufficiently different to support such an unusual type of energy conservation.

http://onlinelibrary.wiley.com/doi/10.1111/1758-2229.12524/full

Microbial Biotechnology

www.microbialbiotech.com

Editorial: the microbiome as a source of new enterprises and job creation

The do-it-yourself movement as a source of innovation in biotechnology – and much more

Víctor de Lorenzo, Markus Schmidt

Will do-it-yourself biology (DIYBio) change the game for biotech innovation?

In recent years growing numbers of people have embraced what is commonly labelled as biohacking, amateur or DIYBio. The term hacking was coined by computer and electronic engineering students at MIT who, in a playful competition, demonstrated their ingenuity in rewiring the control circuit of a model railroading system. While initially referring to any type of clever solution, hacking was eventually also done in computer systems for which the term became famous. Contrary to the popular belief that hackers carry out criminal activities, their culture may be described by four

interrelated goals: (i) to investigate a subject for its own sake, (ii) to engage in non-destructive mischief, (iii) to do something out of the ordinary or clandestine and (iv) to crack the inaccessible. Over the years, students and engineers, first at MIT and then all over, have maintained hacking as a self-driven, problem-solving state of mind that autonomously searches and identifies challenges to be resolved. Whether DIYBio will change the game for biotech innovation remains to be seen, but certainly the trend towards a broader involvement of more players in the design and fabrication of new business ideas will continue.

http://onlinelibrary.wiley.com/doi/10.1111/1751-7915.12715/full

Detoxifying symbionts in agriculturally important pest insects

Tijs J.M. van den Bosch, Cornelia U. Welte

Pest insects lead to excessive agricultural and therefore economical losses on crops worldwide.

These insects have to withstand toxic molecules that are inherent to plant defences, as well as those that are produced and introduced by humans in the form of insecticides. In recent years, research on insect–microbe symbioses has recognized that microbial symbionts may play a role protecting against these toxins, leading to a form of defensive symbiosis between the pest insect and different types of microorganisms that the authors term detoxifying symbioses. This mini-review highlights well-characterized and emerging insect model systems of detoxifying symbioses and assesses how the microorganisms influence the host's success.

http://onlinelibrary.wiley.com/doi/10.1111/1751-7915.12483/full

Journal of Applied Microbiology

www.journalappliedmicro.com

Laundry hygiene — how to get more than clean

D.P. Bockmühl

This review compiles the different factors that influence the input and removal of microorganisms in the laundering process and discusses the possible adverse effects of microbial contaminants in the washing machine and on textiles as well as suitable counteractions.

Although laundering should mainly remove stains and dirt from used and worn textiles, the elimination of microbial contamination is an important aim of the laundry process as well. While industrial and

institutional laundering employs standardized processes using high temperatures (i.e., 60°C and above) and bleaching agents to ensure a sufficient hygienic reconditioning of textiles, domestic laundering processes are less defined and not always led by purposeful aims. The strive for energy efficiency of household appliances has resulted in a decrease in washing temperatures in Europe during the last decades and convenience aspects led to an increased use of liquid detergents that do not contain bleach, which in turn impacts the antimicrobial efficacy of domestic laundering.

http://onlinelibrary.wiley.com/doi/10.1111/jam.13402/full

Aerobic metabolism in the genus *Lactobacillus*: impact on stress response and potential applications in the food industry

T. Zotta, E. Parente, A. Ricciardi

This review outlines the recent advances in the knowledge on aerobic and respiratory growth of lactic acid bacteria, focusing on the features of respiration-competent lactobacilli.

The species of the genus *Lactobacillus* have been traditionally classified as oxygen-tolerant anaerobes, but it has been demonstrated that several strains are able to use oxygen as a substrate in reactions mediated by flavin oxidases and, in some cases, to synthesize a minimal respiratory chain. The occurrence of genes related to aerobic and respiratory metabolism and to oxidative stress response apparently correlates with the taxonomic position of lactobacilli. Members of the ecologically versatile *Lactobacillus casei*, *L. plantarum* and *L. sakei* groups are apparently best equipped to deal with aerobic/respiratory growth. The shift from anaerobic growth to aerobic (oxygen) and/or respiratory promoting (oxygen, exogenous haem and menaquinone) conditions offers physiological advantages and affects the pattern of metabolite production in several species. Even if this does not result in dramatic increases in biomass production and growth rate, cells grown in these conditions have improved tolerance to heat and oxidative stresses. An overview of benefits and of the potential applications of *Lactobacillus* cultures grown under aerobic or respiratory conditions is also discussed.

http://onlinelibrary.wiley.com/doi/10.1111/jam.13399/full

Letters in Applied Microbiology

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Antibiotic resistance in *E. coli* in husbandry animals: the African perspective

C.A. Alonso, M. Zarazaga, R. Ben Sallem, A. Jouini, K. Ben Slama, C. Torres

In the last few years, different surveillances have been published in Africa, especially in northern countries, regarding antimicrobial resistance among husbandry animals. Information is still scarce, but the available data show a worrying picture.

Although the highest resistance rates have been described against tetracycline, penicillins and sulphonamides, prevalence of plasmid-mediated quinolone resistance genes and extended spectrum β-lactamase (ESBL) are being increasingly reported. Among ESBLs, the CTX-M-1 group was dominant in most African surveys. Certain $bla_{CTX\text{-}M\text{-}15}$-harbouring clones (ST131/B2 or ST405/D) are mainly identified in humans, but they have also been reported in livestock species from Tanzania, Nigeria or Tunisia. Moreover, several reports suggest an inter-host circulation of specific plasmids. International trade of poultry meat seems to have contributed to the spread of other ESBL variants, such as CTX-M-14, and clones. Furthermore, first descriptions of OXA-48- and OXA-181-producing *E. coli* have been recently documented in cattle from Egypt, and the emergent plasmid-mediated colistin resistance *mcr-1* gene has also been identified in chickens from Algeria, Tunisia and South Africa. These data reflect the urgent need of a larger regulation in the use of veterinary drugs and the implementation of surveillance programmes in order to decelerate the advance of antimicrobial resistance in this continent.

http://onlinelibrary.wiley.com/doi/10.1111/lam.12724/full

Meticillin-resistant *Staphylococcus aureus*: a controversial foodborne pathogen

D. Sergelidis, A.S. Angelidis

This review evaluates the potential of meticillin-resistant *Staphylococcus aureus* (MRSA) as foodborne pathogens based on current knowledge about the epidemiology of MRSA, their prevalence in livestock, foods of animal origin and humans, and their ability to produce enterotoxins.

MRSA is a major cause of severe healthcare-associated (HA) infections. Although during the last decade the incidence of HA invasive infections has dropped, the incidence of community-associated MRSA (CA-MRSA) infections has risen among the general population. Moreover, HA-MRSA, CA-MRSA and livestock-associated MRSA (LA-MRSA) can be found in foods intended for human consumption. Studies from different geographical areas have reported the presence of enterotoxin genes in several MRSA food isolates. Molecular typing studies have revealed genetic relatedness of these enterotoxigenic isolates with isolates incriminated in human infections. The contamination sources for foods may be livestock as well as humans involved in animal husbandry and food processing. Enterotoxigenic *Staph. aureus* isolates present in foods can cause staphylococcal food poisoning (SFP), irrespective of the contamination origin. SFP is the result of the consumption of foods with preformed enterotoxins. Hence, similar to meticillin-sensitive enterotoxigenic *Staph. aureus*, enterotoxigenic MRSA can also act as foodborne pathogens upon favourable conditions for growth and enterotoxin production.

http://onlinelibrary.wiley.com/doi/10.1111/lam.12735/full

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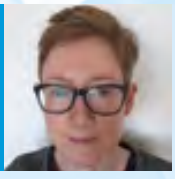

Claire Fewson
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NCIMB collaborates with EnteroBiotix to develop microbial therapeutics for faecal microbiota transplantation

NCIMB is collaborating with award-winning biotechnology company EnteroBiotix, in the development of microbial therapeutics for use in faecal microbiota transplantation. It is hoped that the collaboration will represent a significant step in the development of the therapeutics.

EnteroBiotix was established to support doctors in treating a range of diseases by tapping into the power of the bacterial populations flourishing inside the human gut. The company is developing a pipeline of medicinal products that aim to restore the balance of bacteria in patients suffering from diseases and conditions such a *C.difficle* infection and inflammatory bowel disease.

Initially, NCIMB will support EnteroBiotix in the development of a suspension of microbial communities derived from a healthy donor, and manufactured in compliance with good manufacturing practice (GMP). Future work will bring together NCIMB's culture collection with EnteroBiotix's GMP platform to explore the potential of new genera in the development of microbial therapeutics.

James McIlroy, CEO of EnteroBiotix explains: "*Faecal Microbiota Transplantation is a NICE approved medical treatment, but there is no national donor registry or infrastructure in place to deliver donated material to doctors. Our aim is to solve the pain points that doctors currently face by developing orally administered microbial therapeutics for use in the procedure*".

Further Information

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Non-tuberculous Mycobacterium type strain sequences available from NCTC

The NCTC 3000 project aims to generate 3000 reference genomes from bacterial strains of global public health importance held within NCTC and to make them publicly available to scientists globally. To date we are pleased to announce that we have sequenced seventeen Mycobacterium type strains from our collection and these are now available via the European Nucleotide Archive (ENA) and the Wellcome Trust Sanger Institute website:

http://www.sanger.ac.uk/resources/downloads/bacteria/nctc/

Strain	NCTC Number
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M. aichiense	NCTC 10820
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M. chitae	NCTC 10485
M. flavescens	NCTC 10271
M. gadium	NCTC 10942
M. gilvum	NCTC 10742
M. marinum	NCTC 2275
M. nonchromogenicum	NCTC 10424
M. peregrinum	NCTC 10264
M. phlei	NCTC 8151
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Neogen Develops Fastest Listeria Test with No Enrichment

Neogen Corporation (NASDAQ: NEOG) has developed an innovative test that detects *Listeria* in environmental samples in under 60 minutes — without the need to enrich samples.

Neogen's new *Listeria* Right Now™ test system can detect all species of *Listeria*, including the pathogenic *L. monocytogenes*, in under 60 minutes through their ribosomal RNA (rRNA). The system's effectiveness has been validated by NSF International to detect low levels of *Listeria* in environmental samples with greater sensitivity and speed than any other method available. The test is also under review for AOAC Performance Tested certification to further validate its accuracy.

The innovative *Listeria* Right Now process starts with taking an environmental sample to capture any *Listeria* present. The entire swab sample is placed in a tube that contains a lysis buffer that breaks up any bacteria present, and releases its rRNA. If *Listeria* is in the sample, the test's reagents will amplify thousands of copies of its rRNA — and make the *Listeria* easily detectable by *Listeria* Right Now.

In the validation study of *Listeria* Right Now comparing the test against the reference cultural method, NSF International confirmed the effectiveness of this new test. The evaluation determined that under the conditions employed in this study, the enrichment-free *Listeria* Right Now method is as sensitive as the enrichment-based culture reference method.

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Hopes, hypes & multivallate defences against antimicrobial resistance

Professor Neil Woodford is Head of the Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit at Public Health England. His Unit, based at Colindale, north London, is a WHO Collaborating Centre. Neil is a Visiting Professor at Imperial College London where he also did his doctoral studies on *Neisseria gonorrhoeae*, and an Honorary Professor at Queen Mary University of London, at University College London, and at the University of KwaZulu-Natal (South Africa). Neil has worked on antimicrobial resistance for over three decades and has co/authored over 350 publications and edited three books on diverse aspects of this subject. A Fellow of the Royal College of Pathologists, he has been an editor of the Journal of Antimicrobial Chemotherapy. Neil's particular interests include antibiotic resistance mechanisms in bacterial pathogens, molecular analysis to track dissemination of resistance, and molecular diagnostics for rapid detection of resistance. He sits on many national and international committees relating to antimicrobial resistance, and served as the Scientific Advisor to Lord Jim O'Neill's *Review on Antimicrobial Resistance* (2014-16).

Professor Neil Woodford

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