

BACTERIAL WORLD EXHIBITION REPORT

19 October 2018 – 28 May 2019

An exhibition and events programme on the hidden story of bacteria and their influence on the past, present and future of our planet.

www.oum.ox.ac.uk/bacterialworld



Supported by the EPA Cephalosporin Fund



Supported using public funding by
**ARTS COUNCIL
ENGLAND**



BACTERIAL WORLD IN NUMBERS

39 exhibition events

174,805 visitors

101 researchers involved

787 visitors a day on average

50+ items on display

43,000+ visits to website

2 fermentation workshops

87,393 interactive uses

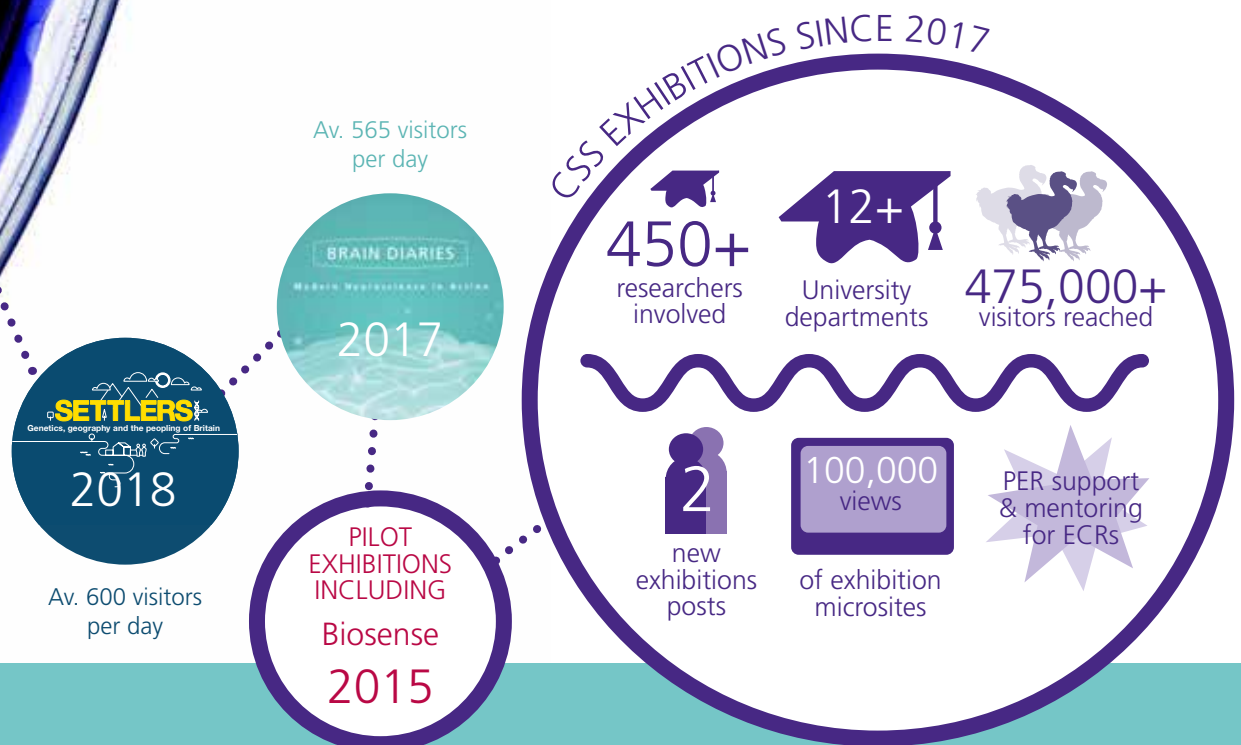
6,576 visitors to events

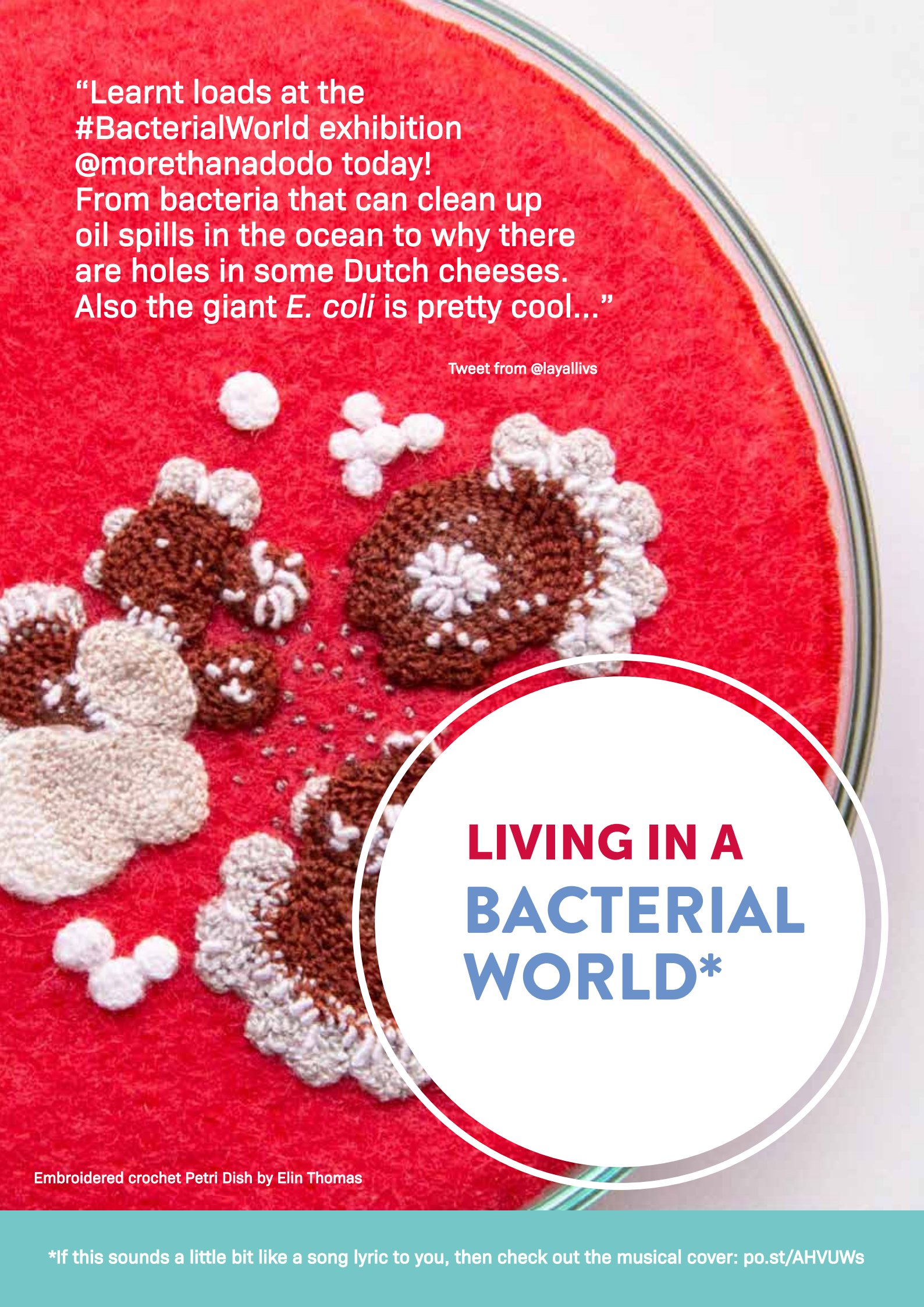
Contemporary Science and Society: Exhibitions and Programming Series

In 2014, the Oxford University Museum of Natural History (MNH) commenced the planning of a new series of Contemporary Science and Society exhibitions (CSS). The CSS programme aims to connect the research power of academic departments within the University of Oxford with the very large audiences visiting the Museum. The programme is led by the multiple award-winning public engagement team of the Museum, in partnership with scientists and public engagement officers embedded within wider University departments.

At the start of the programme 640,000 people visited the museum each year, with this steadily increasing to almost 800,000 in 2019. MNH is the most visited university science museum globally, and is the most visited UK science museum outside the nationals. The large public audience, globally-leading research of University researchers, and experienced team at the Museum provide unique and exciting opportunities for developing innovative and collaborative public engagement with research.

The first exhibition in the series, Biosense, opened in May 2015. Research relationships that began at this initial exhibition led to the development of Bacterial World, the sixth exhibition in the series, and the most ambitious yet.



A close-up photograph of a petri dish containing a red, textured surface. On this surface, several clusters of white and brown, fibrous, and irregularly shaped objects are scattered, resembling bacterial colonies or mold. The objects vary in size and shape, some being small and round, others larger and more complex. The background is a solid, vibrant red color.

“Learnt loads at the
#BacterialWorld exhibition
@morethanadodo today!
From bacteria that can clean up
oil spills in the ocean to why there
are holes in some Dutch cheeses.
Also the giant *E. coli* is pretty cool...”

Tweet from @layallivs

LIVING IN A BACTERIAL WORLD*

Embroidered crochet Petri Dish by Elin Thomas

*If this sounds a little bit like a song lyric to you, then check out the musical cover: po.st/AHVUWs

TELLING THE UNTOLD STORY OF BACTERIA

Malcolm M. Campbell @malcolm_mcampbell
It was impossible to imagine Oxford Museum of Natural History (@morethanadodo) elevating its awesomeness.
But then they installed a spectacular, giant E. coli sculpture by @lukejerram.
Phenomenal!
#BacterialWorld #SciArt #microbes
Photo by: @museumsmithery



Bash The Bug @BashTheBug · Feb 26
Visiting the #BacterialWorld exhibition at @morethanadodo in Oxford. Great to see the display talking about all the amazing work my @morethanadodo volunteers do helping us tackle tuberculosis.


Plant Sciences @OxfordPSci · 22 Oct 2018
Isn't this new #BacterialWorld @morethanadodo exhibit stunning? Very grateful of the contribution by @morethanadodo @OxfordPSci team. Keep your eyes peeled to find the samples of the pea-roots using a rhizobia companion system, as provided by @BBSRC @BBSRCUK


Dr James Blackland @Comms1100 · Apr 17
Currently at the awesome #BacterialWorld Oxford, great example of public engagement with science #morethanadodo especially loving the knitted Petri dishes, can you spot the giant #BashTheBug? - At Oxford University Museum Of Natural History


Science is lifting the lid on the secret lives of bacteria – and revealing how these small organisms are the key to understanding ourselves and some of our biggest questions. The Bacterial World exhibition aimed to bring this research to the Museum’s many visitors in an innovative and engaging way through a special exhibition and events programme from 19 October 2018 to 28 May 2019. Professor Judith Armitage FRS (Department of Biochemistry, University of Oxford), was the lead researcher on Bacterial World, bringing a network of scientists who contributed to the displays and programme.

Bacterial World sought to tell the natural history of bacteria - how they shaped the Earth’s past, and continue to wield huge influence over us all. Research has only recently revealed how much our lives are inextricably linked with the lives of bacteria, as well as insights into how bacteria survive, thrive, fight and die by the trillion every moment. They swim using nanoscopic motors, and battle with spears. They sense, communicate, remember. Research on the symbiotic relationship between bacteria and plants and animals such as nitrogen fixation in plant roots, light production in animal bodies and the effect of the gut biome on human health were a particular focus to demonstrate how we really are living in a bacterial world.

The exhibition attracted 174,805 visitors and the varied events programme engaged over 100 researchers with a combined event audience of 6,576 people.

The exhibition was funded by several research grants including a major donation from the EPA Cephalosporin Fund, BBSRC support, and a significant contribution from the Foster Lab for the gamified research interactive, Gut Wars, featured in the gallery. Financial support was also provided by the Museum through staff time and access to wider Museum resources.

The #bacterialworld Twitter feed is full of positive responses to the exhibition, from members of the public responding to the displays, art installations and events, to the diverse range of participating University departments.

WORKING WITH RESEARCHERS

BUILDING NEW RELATIONSHIPS

The CSS exhibition series provides an opportunity for the Museum to strengthen and build new relationships with departments across the University, in particular the Science Area that the Museum sits in the heart of. Professor Judith Armitage FRS, the lead researcher for Bacterial World, enabled access to a global research community that provided content for the exhibition as the project developed.

“We had wonderful brainstorming meetings, engaging senior and junior scientists across University departments. What they have done with our snippets of knowledge is to produce something beyond anything I could have imagined.”

Professor Judith Armitage

DEVELOPING CONTENT

The content of the exhibition develops through a collaborative process of researcher interviews with Museum exhibition officers, monthly team meetings over five months, and ongoing correspondence. The meetings are led and hosted by the Museum, with the Museum’s collections and wider resources available to support the development of the exhibition content.

Additionally, the public engagement team’s connections with external science writers, graphic designers and digital interactive developers enables the smooth production and realisation of innovative display needs. The Museum is keen to host existing projects in exhibitions, from digital displays to information on how visitors can get involved with citizen science. **Bash the Bug** is a citizen science project that featured in the exhibition, that helps researchers determine the use of antibiotics to treat different strains of Tuberculosis. Gamified research initiatives like the **Gut Wars** interactive allowed visitors to pitch different bacteria against each other to learn about microbial competition.

The public programme of events is planned alongside the development of the exhibition content providing further opportunities for sharing research in alternative, performative ways beyond the limits of displays. Researchers involved in the development are offered evening talks in the exhibition programme.



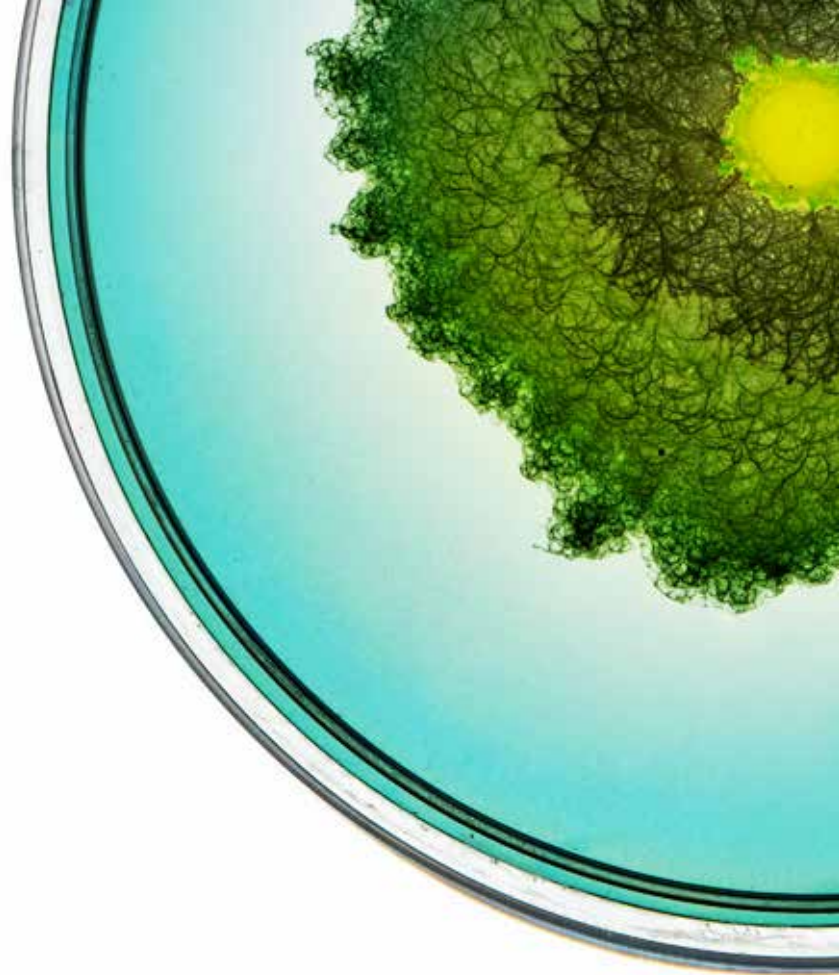
Meetings at the Museum were opportunities for researchers to network, view collections, and develop ideas for all aspects of the exhibition from text to digital interactives.

PROJECT LEGACY

Bacterial World was a temporary exhibition running for seven months. The impact of the project is designed to last beyond the exhibition run.

The Bacterial World exhibition website, put together by Museum staff using the Shorthand platform, contains the majority of the exhibition text, images, and digital components, available for anyone to read and share. Since the launch of the exhibition in October 2018 until the end of 2019 the site has had 43,000 views, which includes people who have visited the exhibition and wanted to re-read some exhibition content, and others who have been unable to visit in person. The website will be maintained online as a resource and as a legacy to the physical exhibition, with a review of its online content planned over the next four years.

Additionally, the exhibition programme of events, use of high impact statement artworks, and considered engagement with Museum audiences all aim to ensure the impact of the exhibition content endures beyond the life span of the physical display. For Bacterial World this included arranging loans of artworks, and working with wider Museum colleagues to deliver more structured and bespoke audience engagements with exhibition content.



A film depicting the processes involved in Bacterial World was produced as a Public Engagement Case Study
<https://www.mpls.ox.ac.uk/public-engagement/latest/watch-bacterial-world-exhibiting-research-case-study>



The Museum's public spaces are a great place to engage visitors with exhibition themes as part of developing content, along with use of the expertise of Museum staff from exhibition build to education.



KEY MESSAGES

Four statements helped define the overall aims of the exhibition content:

Understand more about where bacteria are, how they operate and that they bring many benefits as well as causing harm

Feel surprise and awe at the scale of the influence of bacteria on us and our planet

Discover how scientists study bacteria

Be motivated to learn more about geology, zoology, botany, microbiology, biochemistry or biomedicine, for example through the exhibition website or events programme.

NARRATIVE ARCS

The exhibition was divided into three key sections to help with storytelling and create flow between the large variety of bacteria featured:

World building bacteria began the narrative, highlighting the role of bacteria as one of the earliest forms of life on the planet, and helping create a habitable place for other life forms by producing oxygen.

World shaping bacteria explored the many ways we live with bacteria from symbiotic relationships with animals to fermenting food.

World changing bacteria featured contemporary research into understanding how bacteria function and how to harness this for research.

DISPLAY DESIGN

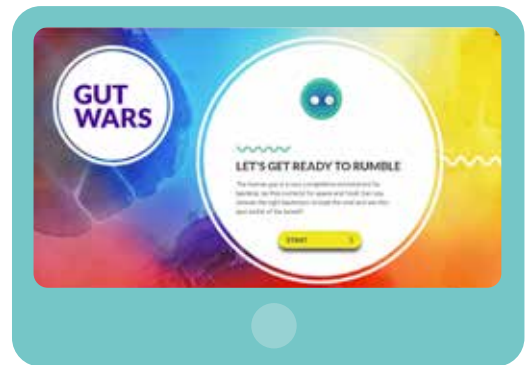
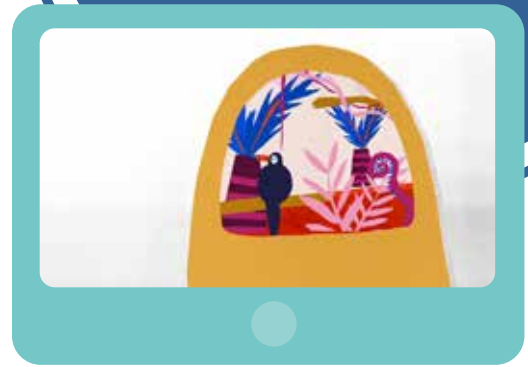
The Museum worked with the design agency Easy Tiger Creative to create dynamic graphic displays providing context and interpretation for specimens on display. Visual diagrams and infographics were also produced to help communicate aspects of display, and quotes from scientists whose research featured were included at various points along the exhibition run. Striking imagery was sourced by the Museum team for use in the exhibition.

DIGITAL DESIGN

One of the aims of the CSS series is to make visible the people conducting research at the University. In Bacterial World, vertical 'talking head' screens allowed visitors to see and hear scientists talking about their research, including an interactive Q and A function. An animation called **Bacteria Safari: The forest on your fingernail** from Oxford Sparks featured in the exhibition as well as on a screen at the entrance to the Museum.

Two digital interactives - **Gut Wars** and the **Bacteria Explorer** - were developed for the exhibition by drawing on the latest research. Gut Wars was developed with researcher Professor Kevin Foster (using allocated BBSRC funds from the Foster Lab) working closely with the Museum's digital lead and external developers Fish in a Bottle to produce a popular game where users picked gut bacteria with specific attributes to fight against each other. This received **62,452 page views** during the course of the exhibition. The Bacteria Explorer interactive received **24,941 page views** and allows visitors (online and in the gallery) to grapple with the scale of the microscopic world and learn about different bacterial forms and their physical characteristics. The Museum collaborated with another nine researchers in an interactive audio exhibit, looking ahead to how we can harness bacteria to tackle some of the big issues facing our planet, such as do bacteria hold the key to greener energy?

THE EXHIBITION



Visitors playing Gut Wars in the gallery.

Oxford University Museum of Natural History began as a Victorian vision of art and science. The architecture of the building, completed in 1860, celebrates craftsmanship and the direct observation of nature. In this spirit, the Museum has sought to feature art prominently in Contemporary Science and Society exhibitions. Bacterial World included artworks to engage audiences in new and exciting ways, most notably with a large inflatable *E. coli* bacteria that occupied the length of the Museum's roof for the duration of the exhibition.

ARTWORK LOANS

The giant inflatable artwork, *E. coli* by Luke Jerram, was loaned from Sheffield University and new interpretation panels helped link the giant, floating artwork to the exhibition on the first floor. As soon as visitors, staff and the press saw the artwork, it attracted a lot of attention. A couple of days after it was installed, a photo of *E. coli* was named as one of the Guardian's photographs of the day, alongside images of Theresa May and Grayson Perry. It was also a social media success, performing as the Museum's most popular post on Facebook in 2018 with a similarly record number of 3,966 engagements. On Instagram it remains our most popular post ever, with 980 likes and comments like 'saw this yesterday – it looks fantastic!', 'whoaaaaa this is so cool' 'Holy Coli' 'cool exhibition to go see'. Two, smaller glass artworks depicting another *E. coli* and a *Salmonella* bacteria by Luke Jerram were also loaned from the Wellcome Collection and displayed in the exhibition gallery, also attracting considerable attention, and helping to make visible the tiny bacterial subjects of the show.

COMMISSIONING NEW ARTWORK

Eight Petri dishes of crochet art were commissioned from artist Elin Thomas for the exhibition. These artworks were based on images of agar plates resulting from a drop-in activity at the Museum that also sought to engage visitors with information about the bacteria that surround us everyday. Museum staff and visitors brought in everyday objects such as keys and rings to be pressed into agar in order to leave traces of bacteria. These were then incubated until bacterial colonies were visible to the naked eye and photographed, with Elin copying the images in crochet form. These small and delicate artworks featured at the beginning of the exhibition and were also some of the most popular items on display.



Elin Thomas' crocheted bacteria grown from a baby's sock, a wedding ring, and a USB stick.



**ART AND
SCIENCE**

**LOANS & NEW
COMMISSIONS**

Luke Jerram's glass *E.coli* artwork on loan from the Wellcome Collection.



**ART AND
SCIENCE**

BEAUTIFUL
BACTERIA

ART AND SCIENCE CREATIVE PROJECT WITH IFFLEY ACADEMY

In addition to the public exhibition programme, a special arts project was developed for Bacterial World by the Museum's Public Engagement team working with artist and puppet maker Georgina Davy and Iffley Academy, a school in Oxford for children with special educational needs and disabilities (SEND).

Through a series of specialised workshops children were provided with opportunities to learn about the science of bacteria and create their own artistic interpretations of microbes. Post-doctoral researcher Dr Frances Colles, who studies *Campylobacter*, its spread and impact, worked with the school and Museum to run a workshop all about bacteria. She talked about her work, answered questions about being a scientist, and ran a series of engaging activities about the form and function of bacteria. Georgina Davy ran three day-long workshops where the students made small elements of designs for large bacteria puppets including a variety of textile techniques such as finger-knitting and plaiting, traditional Japanese Shibori dyeing, as well as modelling with clay. The children's artworks were then incorporated into the final designs for three larger-than-life bacterial puppets that explored different ways of moving. Throughout the project, students from the participating class also completed log books which contributed to their national Arts Award qualification applications.

Once the final puppets were completed by Georgina, they were taken to the school and performed with music. A second set of performances later took place with volunteers operating the puppets in the Museum during public opening hours, bringing the project circling back to the Museum space and wider Museum audience.

A temporary display of the project was created for the Museum's Community Case. The Iffley Academy students came to the Museum to see the display and participate in a final celebration.

Additionally, teachers from across Iffley Academy came to the Museum for a training evening. This involved a tour of Bacterial World, a series of creative science activities and inspiration for how they can use the Museum as part of their learning in the future.

BBSRC funding provided this opportunity to create an exciting and involved project for the school, combining artistic practice and scientific research.





EVENTS PROGRAMME

“I admit, when making these timelapses of #bacteria in the lab, I never imagined I would one day watch them played to music by a pianist underneath a #Trex in England. @morethanadodo knows how to throw a bacterial party! #swarming #uncultured #invisibleworlds #sciart #scicomm”

Tweet from @socialmicrobes

EVENING EVENTS

The exhibition launched with a special late night, **Uncultured** including talks, performances and games under Luke Jerram's *E. coli* which had been given a distinctive pink glow for the evening.

Additional novel events included a **comedy night**, a **board game evening**, an alternative **Christmas Party in a Petri Dish**, and a gameshow-like contest **No Bell Prize** for early career researchers to practice science communication without using jargon. Activities and topics covered at these events always linked to themes in the exhibition. For example, the event **Partners for Life** explored symbiotic relationships between bacteria and animals.

TALKS

The Bacterial World events programme featured **8 evening lectures with 10 researchers** involved in the exhibition. These talks addressed a wide range of contemporary research topics, from bacteria around food and domestic spaces, to harnessing disease-causing bacteria to help develop potential cures for genetic illnesses.

7 Science Shorts - informal 30-minute-long Saturday presentations by early career researchers - provided Museum visitors with novel ways to learn about microbe research. These ranged from understanding rhizomes and crop production to having the chance to 'pin the bacteria on the reproductive tract of a jungle fowl'.

WORKSHOPS

Two particularly tasty offers as part of the programme were fermentation-related workshops run by Oxford University DPhil researcher Joshua Evans. His **sauerkraut workshop** in the Museum cafe, overlooking the exhibition, and his **sourdough workshop** with Kate Hamblin hosted in Hamblin Bakery in East Oxford, provided hands-on (edible) learning and received high enjoyment levels in evaluation feedback.



In addition to these bespoke activities, exhibition-themed object handling sessions run by trained volunteers, Bacterial Buddies, took place every other Saturday. Bacterial World themed study days, school holiday activities and a family trail were also developed working closely with the wider public engagement team at the Museum.

A microscopic view of a petri dish containing various bacterial colonies. The colonies are in shades of red, orange, and yellow, appearing as clusters of small, rounded cells. The background is a light pinkish-purple. A dark, curved line, likely the edge of the petri dish, is visible on the right side. A large, dark red circle is overlaid on the left side of the image, containing the title text.

EVALUATING THE EXHIBITION & EVENTS

An extensive evaluation project was developed for Bacterial World aided by new posts specialising in evaluation at the Museum and working with an external consultant and an Oxford DPhil researcher on an internship at the Museum. Highlighted findings showing the success of the exhibition in meeting its aims are summarised here. The full evaluation report written by Dr Jen DeWitt, Maria Ordovas-Montanes, and Georgina Brooke is available as an appendix to this summative report on request.

New evaluation methods were also trialled for the Bacterial World events programme and have been refined and incorporated into the following CSS exhibition, First Animals, open from 12 July 2019 to September 2020.

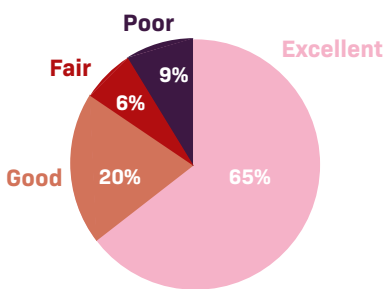
EXHIBITION MAPPING

In-gallery observations and visitor surveys provided evaluative data about Bacterial World, assessing engagement with individual display components and overall visitor flow. From this audience research, it was made clear that the Museum's commitment to displaying science through art, and its development of digital interactives displays, led to higher levels of visitor engagement with the exhibition content. The central theme of the exhibition (world-shaping bacteria) had the largest number of interactions, and observations recorded that visitors chose to move through the exhibition in both directions.

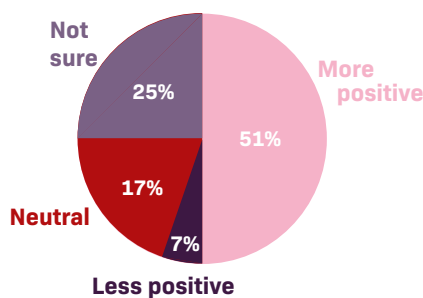
EXHIBITION SURVEY

An exhibition survey questioned visitors on their opinions on the exhibition content and on the Museum as a place showcasing contemporary research. Feedback was positive with 85% rating the exhibition as good or excellent. Over three quarters engaged meaningfully with the content finding it personally relevant. Surveyed visitors understood that bacteria are found everywhere and that they grow and survive; they were able to name benefits bacteria have more broadly as well as recognizing that some bacteria bring harm and that antibiotic resistance is a threat that requires more research. The majority of visitors recognised the Museum as place to come into contact with current research, and over half of visitors stated a changing opinion about bacteria as a result of the exhibition. Many visitors shared that they experienced surprise and awe in the exhibition, amazed to find out how important bacteria are in their lives and to the existence of the planet, and expressed an interest to continue learning more about the subject.

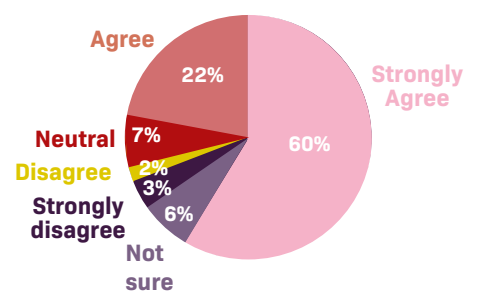
How would you rate the Bacterial World exhibition overall?



Has your view of bacteria changed after visiting the exhibition?



The Museum is a place where I can come into contact with current science and research



Feedback recorded from visitor surveys

78% The quality of the information was about right

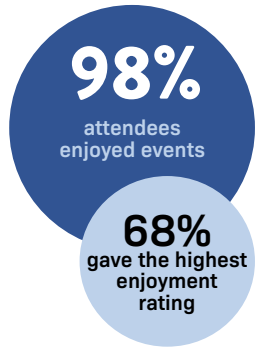
78% The information presented was relevant to me

77% I made use of digital interactives and videos in the exhibition

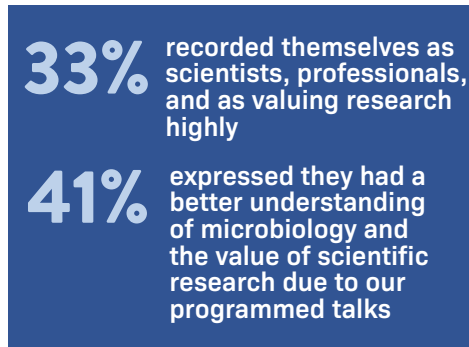
EVENT SURVEYS

Feedback forms collected at the end of our evening talks programmed for Bacterial World showed that they were enjoyable and informative. The majority of the audiences reported evening talks as their first exhibition event, and feedback contained overall positive responses.

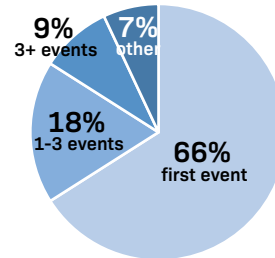
Enjoyment



Learning



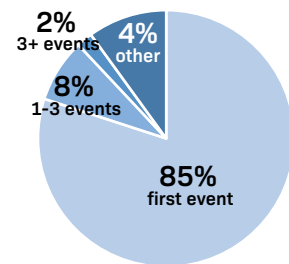
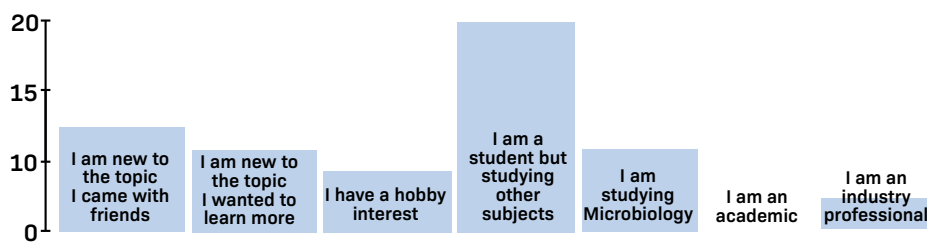
Audience



74% attendees considered their interest in Microbiology at a hobby level at most

35% attendees considered themselves new to the subject

The variety of exhibition events allows for PER opportunities for researchers at different career stages, as well as attracting different audiences. Special evening events, such as our No Bell Prize evening for early career researchers, attracted a slightly different audience from the talks, with higher numbers recording it as their first event, and more students attending.



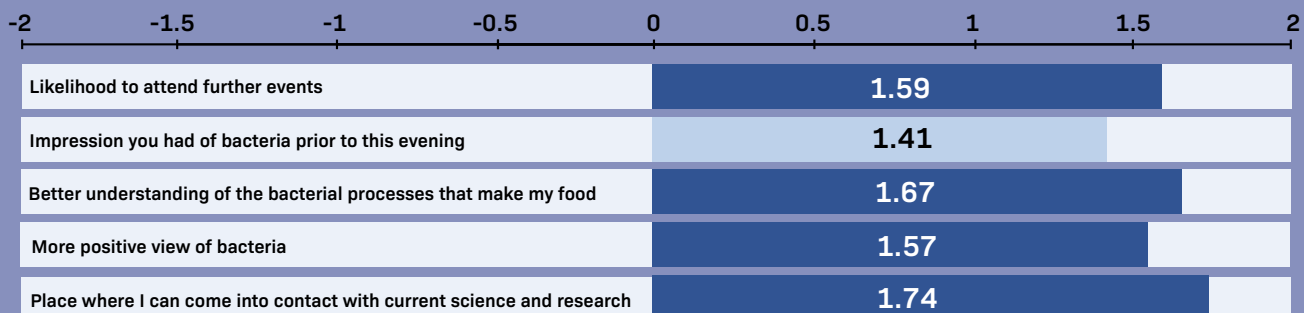
No Bell Prize event audience feedback on self-identified interest in attending

WORKSHOPS

Attendees of the two practical food-based workshops gave very positive feedback, including unprompted praise for the workshop leaders and high scores relating to the impact of the sessions in increasing scientific knowledge through relevant hands-on learning.

“Josh [researcher] gave an extremely articulate and informed insight into his own research in this area, as well as other work. Very accessible for a non-scientist like me!”

“It’s shown how research can be so relevant to everyday life and of interest to all, that it’s not all in a lab but ‘out there’.”



Oxford University Museum of Natural History would like to thank the following people for their contributions to this exhibition:

Lead research consultant: Professor Judith Armitage FRS, Professor of Biochemistry, Department of Biochemistry, University of Oxford, and President of the Microbiology Society

Research consultants:

Dr Ross Anderson, Department of Earth Sciences, University of Oxford

Dr Philip Burnet, Department of Psychiatry, University of Oxford

Professor Kevin Foster, Department of Zoology and Department of Biochemistry, University of Oxford

Dr Jamie Lorimer, School of Geography and the Environment, University of Oxford

Professor Philip Poole, Department of Plant Sciences, University of Oxford

Professor Christoph Tang, Sir William Dunn School of Pathology, University of Oxford

Dr Nicholas Tosca, Department of Earth Sciences, University of Oxford

A special thank you for the contributions made by the following researchers:

Professor Fraser Armstrong, Department of Chemistry; Dr Richard Berry, Department of Physics; Dr Scott Chimileski, Kolter Lab, Harvard Medical School; Dr Rhiannon Evans, Department of Chemistry; Dr Emily Flashman, Department of Chemistry; Dr Susanne Gebhard, Department of Biology & Biochemistry, University of Bath; Dr Kayla King, Department of Zoology; Dr William Smith, Department of Zoology; Dr Nicole Stoesser, Nuffield Department of Medicine

Thank you to Michaela Livingstone-Banks, Owen Green, Tom Fuller and Tom Wilkinson for their help with the exhibition. Thank you to the Museum's Youth Forum for their input into the exhibition's digital interactives.

A special thanks to the following organisations for the loaning of artwork, objects and specimens to the exhibition:

National Oceanography Centre, Southampton

Natural History Museum, London

Oxford Nanopore Technologies

Peabody Museum of Natural History, Yale University

Pitt Rivers Museum, University of Oxford

uBiome

University of Sheffield

Wellcome Collection, London

Finally a special thanks to the many researchers and volunteers who contributed to the programme of events and activities accompanying this exhibition.



With special thanks to researchers and staff from the University of Oxford.
www.oum.ox.ac.uk/bacterialworld



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