Antimicrobial Animals

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We are living in a time of enormous risk. Years of antibiotic overuse and misuse has contributed to a global threat, where an increase in antibiotic resistant bacteria are contributing to approximately 700,000 deaths per year. International institutions such as the World Health Organization (WHO) and the UK government are calling for new antibiotics and strategies to combat resistance[1].

Antibiotic resistance occurs when bacteria adapt to antimicrobial drugs. These bacteria are often referred to as "superbugs", and the drugs used to treat them become ineffective, infections persist in the body, and the risk of spread to others increases[2]. Superbugs are negatively contributing to our healthcare system's ability to treat patients effectively and the world urgently needs to change the way it prescribes and uses antibiotics. Unless new antibiotics or alternative strategies are developed to cope with this problem, society will no longer able to routinely use certain antibiotics. The simplest of medical procedures will also become life threatening.

We Need to Stop Bacteria Getting Together

Dr. Raechelle D'Sa, a Senior Lecturer in the School of Engineering at the University of Liverpool, and Head of the Antimicrobial Biomaterials group; the D'Sa Laboratory (http://dsalaboratory.com), researches the use biomaterials for the creation of antimicrobial surfaces, drug delivery and regenerative medicine. The D'Sa Laboratory has expertise ranging from materials science and engineering to cell biology, and applies engineering methods to create environments to promote cell and tissue growth, and prevent bacterial adhesion.

The group is improving medical devices by putting antimicrobial coatings on catheters, and developing antimicrobial therapies for the treatment of skin, bone and ocular infections. These innovations draw on nature's toolbox for innovative ways of preventing bacteria from sticking to a surface or killing off groups of bacteria that live in communities called biofilms.

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[1] Tagliabue, A., & Rappuoli, R. (2018). Changing Priorities in Vaccinology: Antibiotic Resistance Moving to the Top. *Frontiers in immunology*, v.9: 1068. doi:10.3389/fimmu.2018.01068

[2] World Health Organization (2018) *Antimicrobial Resistance* [online] Available at: https://www.who.int/en/news-room/fact-sheets/detail/antimicrobial-resistance [Accessed: 4th July 2019]

A biofilm is nothing more glamorous than spit or the mucky bits in the bath that need cleaning, can be 1000 times harder to treat using antibiotics[3]. The D'Sa Laboratory are currently investigating a number of approaches to combat this, which are inspired by nature, such as animal skin textures. Sharks, geckos and cicada flies all have different skin textures that can either prevent bacteria from sticking to a surface or kill them on contact. Additionally, Komodo dragon saliva, eucalyptus plants and honey all have potent chemicals that are also able to kill bacteria on contact. If medical equipment is designed with textured surfaces or if some of these naturally derived antimicrobials are used to treat infections, the use of antibiotics might be significantly reduced.

Introducing *Antimicrobial Animals*

One of the wider challenges with antimicrobial resistance is encouraging the public to change their attitudes and behaviours when it comes to antibiotic use and hygiene practices. In 2019, the D'Sa Laboratory collaborated with the STEAM Lab at the University of Liverpool (https://www.liverpool.ac.uk/humanities-social-sciences-health-medicine-technology/themes/arts-lab/), and Mark Roughley, Programme Leader for the MA Art in Science at Liverpool John Moores University (https://www.ljmu.ac.uk/study/courses/postgraduates/art-in-science-ma) on an EPSRC and University of Liverpool funded public engagement project titled *Antimicrobial Avengers* (www.germwars.co.uk).

This art-science collaborative project investigated the impact of a number of creative methods to inform the public about antimicrobial resistance. A series of superhero and animal characters were developed, and presented as comic book stories and sculptures to engage the public. Helen Birnbaum, a ceramic artist and MA Art in Science student designed and produced a set of ceramic animal sculptures featuring macroscopic antimicrobial surfaces, to communicate ideas about these surfaces and their role in antibiotic resistance to a diverse public audience. This collection of *Antimicrobial Animals* includes a Komodo dragon (Figure 1), a family of geckos (Figure 2), and sharks (Figure 3), created using stoneware clay that was fired and glazed using a mixture of ceramic stains and glazes to achieve the final effect.

Did you know that the Komodo dragon has a protein on its tongue that kills increasingly antibiotic resistant MRSA bacteria, and that that geckos have micro-spikes in different sizes all over their skin that are low-adhesion antimicrobial surfaces? The aim of *Antimicrobial Animals* was to create a series of animal sculptures with exaggerated textures for visitors to see and feel antimicrobial surfaces, in order to understand their importance. Accompanying the shark and gecko sculptures were a number of 'touch plates' that presented even larger macroscopic views of skin surfaces with colourful pink representations of bacteria crawling across them (Figure 4). The challenge here was not to emulate a geckos' skin, for example,

[3] Li, B., & Webster, T. J. (2018). Bacteria antibiotic resistance: New challenges and opportunities for implant-associated orthopedic infections. *Journal of Orthopaedic Research*, *v*.36(1): 22–32. doi:10.1002/jor.23656

but to exaggerate the form to make it more obvious and understandable to an audience viewing the animals in a public engagement setting.

The *Antimicrobial Avengers* project culminated in a number of public engagement events including *Light Night Liverpool* (17th May 2019, http://lightnightliverpool.co.uk/whats-on/antimicrobial-avengers/), where the *Antimicrobial Animals* were displayed for public interaction (Figure 5 and Figure 6). The animals are now part of a public engagement toolkit that the D'Sa Laboratory uses in public facing events across the UK.

This exciting collaborative project allowed to Helen work in partnership with a multi-disciplinary art-science team, communicating life-changing ideas about how we as a society combat disease at a time of antibiotic resistance. We have abused the privilege of antibiotics and it is now time to do something about it. Read more about the *Antimicrobial Animals* here https://helenbirnbaumsantibacterialanimals.wordpress.com/.

About the artist

Helen Birnbaum is a ceramic artist from Skelmersdale, UK, with a fascination for the forms, and histories, of viruses and bacteria. She finds inspiration in arresting scientific and social themes, and her previous projects *Memorialising Disease* and *Quarantine Boxes* focus on the act of remembrance of individuals lost to diseases including influenza and AIDS. Read more on her website https://helenbirnbaumsartscienceadventures.wordpress.com/.

Figure captions

Figure 1: *Antimicrobial Animals:* Komodo Dragon

Figure 2: *Antimicrobial Animals:* Family of Geckos

Figure 3: *Antimicrobial Animals:* Sharks

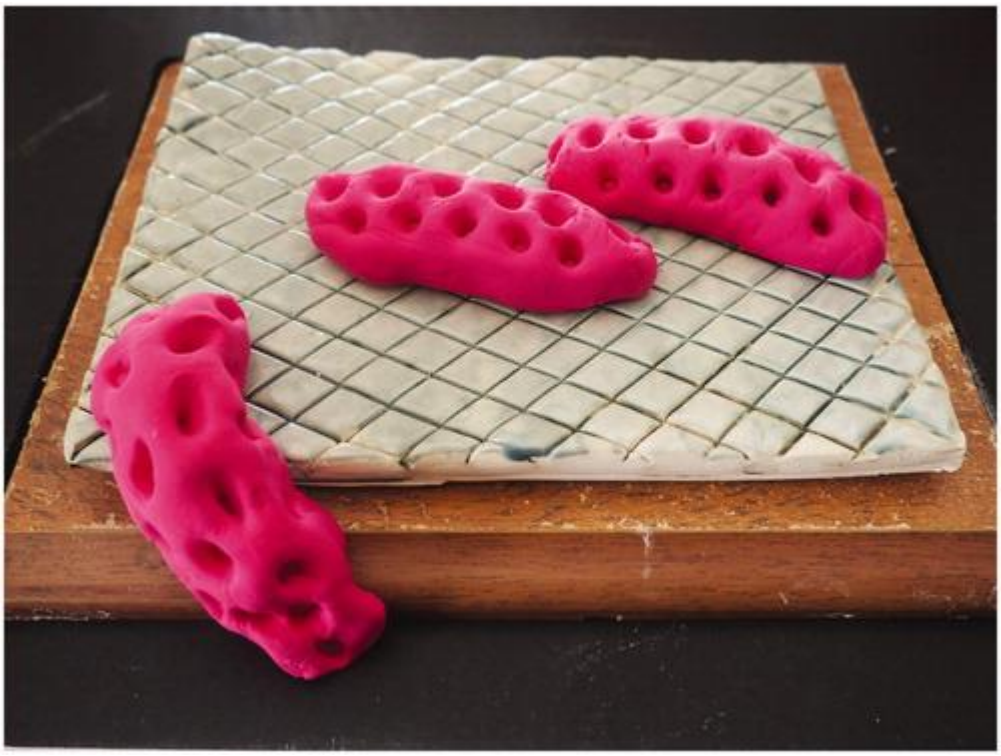

Figure 4: Macroscopic skin textures

Figure 5: *Antimicrobial Animals* on display at the John Lennon Art and Design Building, Liverpool School of Art and Design, for *Antimicrobial Avengers* at Light Night Liverpool (17th May 2019). Photo: Mark Roughley

Figure 6: *Antimicrobial Animals* 'touch plates' on display at the John Lennon Art and Design Building, Liverpool School of Art and Design, for *Antimicrobial Avengers* at Light Night Liverpool (17th May 2019). Photo: Mark Roughley