MICROBIOLOGY SOCIETY

Antimicrobial Resistance Explainer

> " We have to take multiple approaches to address the issue of antimicrobial resistance, to see what works. It cannot be solved by tackling the problem from one perspective and with one group of stakeholders. The problem lies with all of us, as does the solution.
> *Professor Laura Bowater, University of East Anglia* "

Key Points

- The rise of antimicrobial resistance (AMR) is a major threat to modern medicine, as many common and serious infections are becoming increasingly difficult to treat. Without action, the human and economic costs of AMR will increase substantially.

- Addressing AMR and achieving the United Nations (UN) Sustainable Development Goals (SDGs) are intrinsically linked. Microbiology can help to achieve the SDGs by being at the forefront of new innovative interventions and the development of new therapeutics.

- Despite extensive scientific research and policy developments, urgent coordinated action is needed to tackle the threat of AMR.

The Microbiology Society's first president, Sir Alexander Fleming, discovered penicillin in 1928 when mould contaminated a petri dish and killed bacteria. This discovery led to the development of antibiotics that could cure life-threatening bacterial infections. However, Sir Alexander Fleming also famously predicted in his 1945 Nobel Prize Lecture, that bacteria and other micro-organisms would develop resistance.

AMR is a naturally occurring process, whereby micro-organisms (bacteria, viruses, fungi and parasites) can change and adapt over time, either by modifying the target of the antimicrobial, or by developing and exchanging resistance genes. Resistance occurs due to the selective pressure that antimicrobials put on microbes. However, the sustained used of antimicrobials in humans, animals and plants, is speeding up the process. The incidence of AMR is also rapidly increasing in frequency and geographical spread, due to the globalisation of travel and trade; thus triggering a global problem. AMR a multi-faceted issue that spans multiple SDGs and which requires multi-disciplinary approaches for the effective control of its spread, for which microbiologists can offer significant value.

Antimicrobial Resistance and the Sustainable Development Goals

In 2015 the United Nations (UN) adopted the Sustainable Development Goals (SDGs), a set of targets for the world to achieve by 2030. AMR is a very real threat to achieving the UN SDGs, particularly those associated with poverty, food production, the environment and sustainable economic growth (see box 1).

Goal 1: No poverty

AMR jeopardises progress to end extreme poverty as treatments for drug-resistant infections increase. The World Bank's 2017 report 'Drug-Resistant Infections: A Threat to Our Economic Future' suggests that 24.1 million people could fall into extreme poverty by 2030 due to AMR. In addition, the economic cost of AMR also threatens progress to reduce poverty and inequality.

Goal 2: Zero hunger

AMR in animals threatens the sustainability and security of food production and agriculture, which are important for growing populations. The rise of drug-resistant infections in animals will also affect the livelihood of farmers.

Goal 3: Good health and wellbeing

The rise of AMR is a threat to modern medicine, as many common and serious infections are becoming increasingly difficult to treat effectively. AMR also undermines the success of surgery, organ transplantation, childbirth and chemotherapy, as antimicrobials used to prevent infection become ineffective. Antimicrobials are essential components of all healthcare systems and therefore AMR will affect good health and wellbeing.

Microbiology is at the forefront of the development of new antimicrobial compounds and vaccines which could help to achieve good health and wellbeing by limiting the emergence of drug-resistant microbes and protecting currently available healthcare.
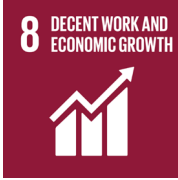
Goal 8: Decent work and economic growth

Without action, the human and economic costs of AMR will increase substantially. It is estimated that global annual deaths could rise from 700,000 to 10 million by 2050, with cumulative economic losses around $100 trillion and a decrease of up to 3.8% of global GDP.

Box 1. Sustainable Development Goals relevant to AMR

1 NO POVERTY	Drug-resistant infections and healthcare	**3 GOOD HEALTH AND WELL-BEING**	Drug-resistant infections and epidemics
2 ZERO HUNGER	Animal health and sustainable food production	**8 DECENT WORK AND ECONOMIC GROWTH**	Cost of AMR on economy

Tackling Antimicrobial Resistance

Reservoirs of antimicrobial resistance

When monitoring AMR, three major reservoirs may be considered: human, animal, and the wider environment. Antimicrobial use in human and veterinary medicine are established as drivers for resistance in humans and animals, respectively. However, the drivers of resistance in the environment and the extent to which human, animal and pharmaceutical manufacturing waste are contributing to the spread of resistant microbes, are currently unclear. Similarly, although antimicrobials, drug-resistant microbes and resistance genes have been detected in soil, rivers, coastal waters, hospital drains and wastewater facilities, the risk to human and animal health associated with environmental contamination is not fully understood. Antimicrobials are also used routinely in aquaculture (farming of fish and food) but estimates of antimicrobial use are variable and the effect on AMR spread unknown.

Transfer of resistance genes

The acquisition of resistance occurs at a genetic level. Our understanding of how AMR genes transfer between the different reservoirs is incomplete. For example, resistance genes have been identified in human and animal microbiomes. However, it is yet to be determined to what extent the microbiome acts as a reservoir of resistance genes and influences the spread of AMR.

Box 2. Interdisciplinary approaches

AMR is a multi-faceted issue that spans multiple SDGs. It requires interdisciplinary approaches for the effective control of its spread, for which microbiologists can offer significant value. Microbiologists investigating alternative therapeutic strategies are already combining their expertise with engineers, immunologists and veterinarians to tackle AMR within a 'One Health' agenda. The successful development and implementation of novel diagnostics by microbiologists also requires collaboration with both clinicians and behavioural scientists. However, for these interdisciplinary approaches to be successful, better training and knowledge exchange between disciplines is required.

Antimicrobial Resistance Policy

Since Lord O'Neill's 2016 AMR Review 'Tackling drug-resistant infections globally: final report and recommendations', important progress has been achieved to tackle AMR at a policy level. The UK's 5-year National Action Plan and 20-year vision, developed collaboratively, with the devolved administrations, is anchored in a 'One Health' approach, a multisectoral approach to addressing the threat of AMR in recognition that resistant micro-organisms arising in humans, animals or the environment may spread from one to the other.

One key strategy to tackle AMR, is to encourage the development of new drugs; previously research has been neglected due to the limited financial incentives for pharmaceutical companies to invest. To address this critical issue, the UK government has proposed the first delinked antibiotic pull incentive; a new model in which the NHS could pay for drugs based on the value they bring rather than on the quantity sold.

Following the adoption of the EU Commission's 'One Health Action Plan' against AMR in 2017, Ireland published its National Action Plan for 2017-2020, which focuses on improving awareness and knowledge of AMR, enhancing surveillance of antibiotic resistance and use, optimising the use of antibiotics, and promoting investment into interventions. This plan was followed by the Irish One Health Surveillance report in 2019, integrating the available data for antimicrobial use and resistance in both humans and food-producing animals.

At a global level, the publication of the UN's Interagency Coordination Group on Antimicrobial Resistance (IACG) report, which provides practical guidance on approaches needed to ensure sustained effective global action, is a major step towards coordinating efforts to tackle AMR.

Whilst there is no specific goal or target in the SDG framework, the World Health Organization has proposed an AMR-specific indicator to the SDG framework under Goal 3 (Good Health and Wellbeing), as part of the 2020 Comprehensive Review of the SDG indicator framework. Adoption of this indicator could help to reinforce the role of AMR and microbiology in achieving the SDGs.

Box 3. A Sustainable Future

To mark the Society's 75th anniversary, we are embarking on a project that will celebrate and champion the role of microbiology in addressing the world's biggest challenges, within the global framework of the United Nations Sustainable Development Goals.

The 'A Sustainable Future' project focuses on three areas where the contribution of microbiology in achieving the goals is particularly significant. These include antimicrobial resistance, the circular economy, and soil health. If you have expertise in one of these areas and would like to share your work with us in the form of a case study please contact us at policy@microbiologysociety.org

Further Reading

HM Government. UK 5-year action plan for antimicrobial resistance 2019 to 2024; 2019.
Interagency Coordination Group on Antimicrobial Resistance. No time to wait: Securing the future from drug-resistant infections; 2019. https://www.who.int/antimicrobial-resistance/interagency-coordina-tion-group/IACG_final_report_EN.pdf?ua=1
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Parliamentary Office of Science and Technology. POSTnote 595: Reservoirs of Antimicrobial Resistance; 2019. https://researchbriefings.parliament.uk/ResearchBriefing/Summary/POST-PN-0595
ReAct. When the Drugs Don't Work: Antibiotic Resistance as a Global Development Problem; 2019. https://www.reactgroup.org/wp-content/uploads/2019/02/When-the-Drugs-Don%E2%80%99t-Work-Antibiotic-Resistance-as-a-Global-Development-Problem-Feb-2019.pdf

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