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Strategic Research and Innovation Agenda

European Partnership on One Health Antimicrobial Resistance



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¹ Research and Innovation Objectives of the EUP OH AMR

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Executive summary

The forthcoming European Partnership on One Health Antimicrobial Resistance (EUP OH AMR) will contribute to the objectives of the EU Action Plan on antimicrobial resistance (AMR), to combat the critical societal challenge of AMR and reduce the burden of AMR by:

- Deploying an interdisciplinary, One Health approach to align and coordinate boosting of AMR research and innovation
- Advancing knowledge on antimicrobial resistance mechanisms, their evolution and transmission routes, the socio-economic drivers of AMR, and barriers to its prevention
- Developing innovative solutions to prevent, detect, monitor, mitigate and treat drug resistant infections and facilitate the uptake of such solutions by industry, policy-makers and society

This Strategic Research and Innovation Agenda (SRIA) will guide the activities of the future European Partnership on One Health Antimicrobial Resistance (EUP OH AMR), a co-funded research and innovation (R&I) partnership expected to start 2025 under the Horizon Europe R&I framework programme². It will deploy a joint research programme, co-funded by the EUP OH AMR partners and the European Commission (EC).

The World Health Organization (WHO) has declared AMR to be one of the top 10 global public health threats facing humanity. Efficient antimicrobials, such as antibiotics, are crucial for the sustained ability to treat infections, perform surgery and other medical treatments. However, decades of inappropriate use and other socio-economic factors have resulted in microorganisms developing resistance to many of the currently available antimicrobials, and without immediate action, we risk reverting to the pre-antibiotic era.

In response to this threat, the EUP OH AMR will contribute to the objectives of the European Union (EU) One Health Action Plan against Antimicrobial Resistance³ and the recently adopted European Commission's proposal for a Council Recommendation on Stepping up EU actions to combat antimicrobial resistance in a One Health approach⁴, by attracting partners from EU and beyond, to align and coordinate strategic One Health AMR R&I policies, and to support joint R&I projects and activities. The EUP OH AMR will build on previous initiatives, such as the Joint Programming Initiative on AMR (JPIAMR), but with stronger integration of social sciences and humanities, innovation and international aspects. It will include a more integrated One Health approach, recognising that human, animal and plant health are independent and interlinked with the environment. Through this approach, the EUP OH AMR will aim to reduce the existing

² Horizon Europe Work Programme 2023-2024, Health

³ EU One Health Action Plan against AMR (2017)

⁴ European Commission proposal for Council Recommendation on AMR (26 April 2023)

fragmentation of the R&I landscape, thus enabling the different One Health sectors and scientific disciplines to tackle the complex challenge of AMR with joint forces.

The R&I objectives of the EUP OH AMR aim to understand, prevent and tackle AMR under five thematic areas: Therapeutics, Diagnostics, Surveillance, Transmission and Evolution and Interventions for prevention and mitigation. In order to ensure an efficient uptake of solutions and use of scientific evidence, the EUP OH AMR will engage, already at the planning stage of the transnational R&I calls and activities, with a broad range of stakeholders, including small and medium-sized enterprises (SMEs), industry, health-care professionals, patient groups, civil society and policy-makers.

The current SRIA should be considered as a preliminary draft and will be subjected to several consultations before it is adopted by the EUP OH AMR partners by the start of the Partnership in 2025.

Introduction and challenges

Almost 100 years have passed since Alexander Fleming's discovery of penicillin. Since then, many other antimicrobials have been developed, and the succeeding decrease in deaths due to infectious diseases and increase in life expectancy have been dramatic.

Unfortunately, microorganisms have the capacity to adapt and develop resistance to antimicrobials through genetic modifications and overuse and inappropriate use of antimicrobials, as well as other socio-economic factors, increase the probability of resistance development. We are now running out of therapeutic options, and risk reverting to the pre-antibiotic era where even small wounds and routine surgery can become lethal. So far, the main focus has been on resistance to anti-bacterial (antibiotic) resistance, but anti-fungal, anti-parasitic and anti-viral resistance are emerging threats.

Antimicrobial Resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to antimicrobial medicines (such as antibiotics), making infections harder to treat and increasing the risk of disease spread, severe illness and death.



The WHO recognises AMR as one of the greatest global threats to public and animal health, as well as to food production. AMR challenges the achievement of multiple United Nations (UN) Sustainable Development Goals (SDGs) ^{5,6} as listed below:

It has been estimated that 1.27 million deaths worldwide were attributable to infections caused by bacterial AMR in 2019⁷. The threat is escalated by the lack of supply for several essential antimicrobials. Without immediate action this figure is expected to raise to 10 million deaths through AMR by 2050⁸, exceeding cancer as a major cause of death.



 AMR has been estimated to cause a decrease in global gross domestic product (GDP) by USD 1-3.4 trillion yearly by 2030⁹. In addition, increased mortality and morbidity will also reduce labour supply. Furthermore, the economic burden of AMR on the healthcare systems, will



have also negatively affect the resources available for other diseases.

⁵ Tracking Antimicrobial Resistance in the Sustainable Development Goals, SDG Knowledge Hub (2019)

⁶ Antimicrobial resistance and the United Nations sustainable development cooperation framework: guidance for United Nations country teams (2021)

⁷ Antimicrobial Resistance Collaborators, *Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis*, The Lancet (2022) DOI: 10.1016/S0140-6736(21)02724-0

⁸ O'Neill, J. (2014) Antimicrobial Resistance, <u>Tackling a Crisis for the Health and Wealth of Nations.</u>

⁹ World Bank (2017); Drug-Resistant Infections: A Threat to Our Economic Future

- AMR is a major problem in food-producing animals and is foreseen to result in a 7.5% decrease in livestock output by 2050¹⁰. The problem is reinforced by unnecessary use of antimicrobials in animals and crops in many countries AMR can also spread in the full food supply chain to human pathogens.
- The burden of AMR is unequal, both in the number of affected patients and in the effect on the economy and livestock production, and is disproportionally high in low- and middle-income countries (LMICs). Other vulnerable groups include young children and the elderly. The access to antimicrobials is also unequal.
- Lack of access to clean water and adequate sanitation increases the spread of infectious diseases and AMR. In addition, wastewaters streams often contain high amounts of antimicrobials, especially from antimicrobial manufacturing sites, but also from hospitals, farms and society at large.

Apart from these SDGs, other global challenges are also affecting AMR, such as climate change (mass flooding, temperature change), war (migration), pandemics and disinformation. Climate change, urbanisation and increased exploration of the nature also result in increased contact between wild-life, humans and domestic animals and hence the spread of AMR.

To respond to these challenges, total and continuous collaboration of all global stakeholders and countries (SDG 17) is essential. To coordinate these actions, WHO published a Global Action Plan on Antimicrobial Resistance¹¹ in 2015, and since then, the severity of AMR has been acknowledged by a number of high-level institutions, including the UN Environment Assembly, the Council of the European Union¹², the G7¹³, the G20¹⁴, the European Union¹⁵ and the UN General Assembly¹⁶.

The COVID-19 pandemic has shown us that human health cannot be kept separated from the health of animals, plants and the environment. In line with this, a **One Health**¹⁷ approach has been put forward, underlining the need for more coordinated action to confront future health threats, such as a potential AMR pandemic. As evident from the above challenges, AMR is a typical example of a One Health problem, where resistant microorganisms or resistance genes are transmitted between humans, animals (including wild-life and companion animals) and plants, often via the environment (for example via waste-water streams from manufacturing sites, hospitals and farms). To emphasise the One Health approach, WHO has joined forces with the Food and Agriculture Organisation of the United Nations (FAO), the World Organisation for Animal





¹⁰ World Bank Infographics (2016)

¹¹ World Health Organization (2015); Global Action Plan on Antimicrobial Resistance; ISBN: 9789241509763

¹² Council of the EU; Press release (17 June 2016)

¹³ G7 health ministers; Communiqué (5-6 November 2017)

¹⁴ G20 Health Ministers; Communiqué (19-20 May 2017)

¹⁵ EU One Health Action Plan against AMR (2017)

¹⁶ United Nations General Assembly, Member States, Communiqué (21 September 2016)

¹⁷ One Health: A new definition for a sustainable and healthy future by the One Health High-Level Expert Panel (OHHLEP), <u>https://doi.org/10.1371/journal.ppat.1010537</u>, June 23, 2022

Health (WOAH) and the UN Environment Programme (UNEP) to form the UN Quadripartite and to develop a One Health Joint Plan of Action¹⁸, in which AMR is one of the action tracks. In addition, "A One Health Priority Research Agenda for Antimicrobial Resistance" is currently under development.

The pandemic also highlighted the fact that microorganisms know no borders, and although the burden of AMR is different in different countries, it easily spreads worldwide with increasing globalisation. In addition, AMR is not only a medical/biological problem but also encompasses socio-economic and behavioural barriers, both in terms of prudent use of antimicrobials and for uptake of solutions.



It is thus clear that a truly inter-sectoral, interdisciplinary and global approach is needed to solve the challenges of AMR. However, fragmentation still exists between different sectors, disciplines and countries, as well as between the researchers and industry at both policy and research levels. Therefore, increased collaboration between sectors and disciplines are highly warranted. To reach this goal, multisectoral coordination and alignment mechanisms are needed, with transparency and representation from all sectors and disciplines, researchers, ministries, funding agencies, the private sector and the civil society.

In order to overcome the numerous challenges of AMR, more R&I is needed to understand the mechanisms of resistance and evolution, as well as transmission routes and drivers, including social factors. Accelerated development of innovative solutions for new treatments, revisited treatment regimens, rapid and affordable diagnostics, surveillance methods and preventive and mitigating interventions are also necessary.

In summary, there is an urgent need for a coordinated One Health and interdisciplinary response to generate increased knowledge and solutions to understand, prevent and tackle the multitude of challenges, both biological and socio-economic, associated with AMR.

¹⁸ <u>Quadripartite One health joint plan of action (2022–2026)</u>

How the European Partnership on One Health AMR will address the AMR challenges

In order to respond to the challenges described above, the EC adopted the "EU One Health Action Plan against AMR"¹⁹. "**Boosting research, development and innovation**" is one of the three main objectives of this action plan. Recently, this Action Plan was followed up by an EC proposal for a "Council Recommendation on Stepping up EU actions to combat antimicrobial resistance in a One Health approach"²⁰, which states that research support is key for the development, evaluation and implementation of measures against AMR. The recommendation also emphasises the importance of continued support and collaboration to strengthen the impact of research and innovation and specifically includes the "establishment of and significant investment in a European partnership to allow coordination, alignment and funding of cross-sectorial research and innovation on "One Health AMR"; the EUP OH AMR.

Thus, the EUP OH AMR is one of the key European partnerships that has been identified within the framework of the Horizon Europe R&I programme to contribute to these objectives.

The EUP OH AMR will enhance coordination and alignment of actions and funding investments among EU countries and beyond, and with support of EU services and thereby strengthen the European Research and Innovation Area (ERA) ecosystem to support R&I in the fight against AMR. It will facilitate national coherence of research programmes, including various aspects and sectors of AMR R&I (e.g. human health, agriculture, environment, industry). The EUP OH AMR will also leverage investments, avoiding unnecessary duplication of efforts and will thus provide support for scaling up R&I efforts. The broad scope of OH AMR R&I requires a high level of integration and coordination that cannot be achieved without a partnership.

The EUP OH AMR will build on the experiences and well-established networks and processes of the Joint Programming Initiative on AMR (JPIAMR), as well as on the R&I outcomes from JPIAMR and other initiatives, such as the One Health European Joint Programming (One Health EJP) and Joint Action on Antimicrobial Resistance (JAMRAI). However, the EUP OH AMR will extend to a broader and more integrative programme to further strengthen synergy and enable cross-sectoral and interdisciplinary research, including social sciences and economics, through a holistic One Health approach. In addition, the EUP OH AMR will have stronger elements of innovation and uptake of solutions by industry, society and policy makers, through reinforced engagement with stakeholders, as well as capacity building and mobility. Furthermore, the EUP OH AMR aims to expand international networks and attract new partners from the EU and link funding agencies from various R&I fields.

¹⁹ EU One Health Action Plan against AMR (2017).

²⁰ European Commission proposal for Council Recommendation on AMR (26 April 2023)

The EUP OH AMR will contribute to reducing the burden of AMR by breaking silos, boost interdisciplinary One Health R&I, develop innovative solutions and provide scientific base for policy, including; enhanced knowledge on resistance mechanisms, evolution and transmission; improved surveillance; better diagnostics; more effective treatment; and enhanced preventing and mitigating interventions to decrease use of antimicrobials and spread of AMR.

The EUP OH AMR will work pro-actively to enforce an interdisciplinary One Health approach by coordinating and aligning national, EU and international AMR R&I policies and actions, in order to increase collaboration between human health, animal health and environment actors, as well as different scientific disciplines in different countries, including widening counties and LMICs, and areas which are hot-spots for AMR incidence. Furthermore, the EUP OH AMR will support capacity building, early career scientists and mobility, and ensure continuous engagement with relevant stakeholders (such as SMEs, industry, patient, health care, farmers, food production and environment organisations, policy makers, EU agencies and international organisations), to ensure that solutions are designed in a way that minimises the barriers for uptake by industry, policymakers and in different socio-economic settings. Whenever relevant, these stakeholders will be actively engaged in the R&I projects and transversal activities of the EUP OH AMR.

By delivering increased knowledge, solutions and evidence-base to **understand**, **prevent and tackle AMR**, the EUP OH AMR will thus contribute to making the EU a best-practice region on AMR with an impact globally.

Scope and boundaries

Within the EUP OH AMR the "One Health approach" will focus on better understanding how the use of antimicrobials and the spread of resistant microorganisms and resistance determinants in and/or between humans, animals and the environment contribute to the emergence and spread of AMR in humans and to its health consequences, and which interventions are effective to control AMR (Figure 1).



Figure 1. One Health scope for the EUP OH AMR.

AMR is a complex problem which will need cooperation of multiple related and relevant research programmes and the EUP OH AMR will work in close collaboration and seek synergy with other European partnerships and international initiatives.

The EUP OH AMR will be in close contact with the European Partnership on Animal Health and Welfare (EUP AH&W) to seek synergies, collaborate on joint activities engage and avoid overlaps in the areas of AMR and animal health. Many of the animal health and welfare measures developed by the EUP AH&W will have a strong contribution to the EUP OH AMR overall goal. Based on preliminary conversations, most R&I on AMR in non-zoonotic, veterinary pathogens for food-producing animals will be covered by the EUP AH&W whereas, for example, AMR in wild-life and companion animals could be addressed by the EUP OH AMR.

The EUP OH AMR will also have a strong integration of environmental aspects of AMR for example, environmental diagnostics and surveillance, understanding the role of the environment in evolution and transmission of AMR and minimising the effect of antimicrobials on the environment.

Additional aspects, such as clinical trials and implementation, will be covered by other EU partnerships, such as Global Health European & Developing Countries Clinical Trials Partnership Joint Undertaking (GH EDCTP3-JU), ERA for Health Research (ERA4Health), the second Joint Action on Antimicrobial Resistance (JAMRAI-2), with whom the EUP OH AMR will seek synergy for various actions and activities. The EUP OH AMR will collaborate closely with JAMRAI-2 and provide scientific base to the implementation of guidelines and national action plans.

The EUP OH AMR will also align and seek synergy with the WHO "Global AMR research agenda in the human health sector, the UN Quadripartite "A One Health Priority Research Agenda for Antimicrobial Resistance" and other international initiatives.

Please see further details on synergies with other partnerships and initiatives on pages 38-42.

Vision, mission and expected impact of the European Partnership on One Health AMR

The EUP OH AMR will contribute to a sustainable transformation of health care, food production, the environment and society at large, in line with the SDGs, by strengthening international cooperation and coordination of One Health responses to AMR in EU and beyond. Through joint support of OH AMR R&I, the EUP OH AMR will contribute to a decreased burden of infectious diseases caused by antimicrobial resistant pathogens. By responding to the emerging threat of AMR, it will address the priority "making Europe more resilient" of the Horizon Europe Strategic Plan²¹.

The EUP OH AMR will also address the objectives of the Pharmaceutical Strategy for Europe²², in terms of fulfilling unmet medical needs on AMR and ensuring that the benefits of innovation reach patients in the EU and beyond. The EUP OH AMR will also contribute to the Farm2Fork strategy²³, by promoting sustainable food production and enhanced food safety and security, as well as the Zero Pollution Action Plan²⁴, by addressing the spread of AMR in the environment. Furthermore, the EUP OH AMR will reinforce Europe's leading role in the fight against AMR by enabling Member States and associated countries to jointly boost R&I on AMR and support informed policymaking to contribute achieving the objectives of the European One Health Action Plan against AMR.

Vision

Reduce the burden of AMR

The common vision of the EUP OH AMR is to improve our response to the threat of AMR by reducing the occurrence and spread of AMR in humans, animals and the environment through an integrated One Health approach.

Mission

To boost One Health research and innovation leading to improved surveillance of resistant pathogens, better diagnostics and effective treatment of infections and to prevention measures reducing the use of antimicrobials and spread of AMR

The EUP OH AMR will strengthen synergy and improve links between One Health R&I to reduce AMR by better coordinating activities and investment and by developing common objectives. It will implement concrete actions for breaking silos, boosting R&I, and development of solutions based on a joint and agreed SRIA to understand, prevent and tackle AMR.

²¹ The Horizon Europe Strategic Plan 2021-2024

²² A Pharmaceutical Strategy for Europe (2020)

²³ The Farm2Fork Strategy (2020)

²⁴ EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" (2021)

Objectives and Intervention logic

The EUP OH AMR will contribute to building a coherent ERA, enabling Member States, countries associated to Horizon Europe and the European Commission to jointly support R&I on AMR, as reflected in the various general, specific and operational objectives. The outputs from the actions under each operational objective are expected to contribute to the outcomes of one or more specific objectives, which combined, will contribute to the expected impact generated from the general objectives.

General objectives

GO1. Strengthen resilience to the AMR threat in Europe and beyond

The EUP OH AMR will strengthen the resilience of the ERA to the AMR challenge by creating a structured AMR R&I ecosystem. This system will provide synergy and coordination of excellent basic research, and innovation development based increased capacity building, programmes for the development of talent, and widening measures to increase the engagement of countries and stakeholders, as well as enhanced international collaboration to mitigate the threat from global hotspots for AMR.

Potential impact indicators for GO1:

- Strengthened global cross-sectoral and cross-border One Health AMR R&I ecosystem
 - Strengthened cooperation of the ERA to support R&I to combat AMR
 - Strengthened capacity (talent, knowledge, data, tools, resources) and integration of a One Health cross-sectoral and transdisciplinary AMR R&I ecosystem
 - Improved dialogue and knowledge exchange between researchers, industry, healthcare, policymakers and end-users

GO2. Enhance evidence-based policy measures and innovative solutions to prevent, detect, control, and treat drug-resistant infections in humans

The EUP OH AMR will generate enhanced knowledge on evidence-based measures to reduce the burden of AMR based on scientific research and innovations.

Potential impact indicators for GO2:

- Knowledge, evidence-based measures and innovative solutions put into action
 - Application of knowledge generated through cross-border, inter-sectoral and interdisciplinary R&I resulting in improved policies and understanding of AMR not only as a biological issue but as a social issue
 - Number of policy documents (guidelines, recommendations, strategic roadmaps) in which funded OH AMR R&I project results are cited
 - Innovative solutions fulfilling unmet medical needs of human patients and animals, reducing the impact of AMR on food security and environment and contributing to the wellbeing of the society and EU meeting policy priorities and SDG objectives

Specific objectives

SO1. Enhance global and European synergy, multi-sectoral collaboration, and alignment of joint strategic OH AMR R&I policies to break silos

The EUP OH AMR will mobilise and link key AMR stakeholders and provide a framework to break existing silos across One Health sectors and scientific disciplines in the AMR R&I landscape. It will structure efforts to curb AMR and facilitate collaboration and joint programming of actions between national and international scientific and policy communities in coordination with industry, practitioners and end-users.

Potential outcome indicators for SO1:

- Alignment of R&I priorities and synergistic actions
 - Alignment with R&I priorities/objectives of the research action plans both at the EU level and with other international initiatives (e.g. WHO)
 - New trans-sectoral and trans-disciplinary collaborations established by the EUP OH AMR (within and beyond Europe)
 - Synergies established by EUP OH AMR with Widening countries and LMICs (country specific research management bodies/ AMR programmes) to enable an environment for co-creating/ exchanges in R&I in different resource settings.

SO2. Boost research & innovation to enhance knowledge and develop solutions to understand, prevent, and tackle AMR

The EUP OH AMR will use a One Health interdisciplinary approach to:

- Improve the understanding of AMR by identification of novel mechanisms of resistance, characterisation of the transmission routes, including socio-economic factors, and evolution of the resistance
- **Prevent the development and spread of AMR** by the design of preventive interventions to control AMR, including the development and testing of stewardship protocols, improved surveillance, and development of diagnostic tools and treatment selection solutions
- **Tackle AMR** by developing innovative treatment solutions, as well as technologies and strategies to reduce AMR in contaminated environments

Potential outcome indicators for SO2:

- R&I based knowledge generation and development of systems-wide solutions
 - Number of antimicrobial targets and candidates, therapeutic alternatives, new and improved diagnostics developed
 - Number of innovative products, processes or methods resulted (including IPR applications); creation of start-ups/companies as drivers of innovation
 - Scientific basis for the development of possible future regulatory framework/legislation proposals/policy
 - Number of evidence-based treatment regimens, stewardship and prevention programmes developed
 - Number of original research articles, guidelines, recommendations, strategy roadmaps published (with open access status)

SO3. Enhance knowledge translation and uptake of research and innovations into solutions and evidence-based policy

The EUP OH AMR will support translation and implementation of scientific knowledge and innovations into products/measures/solutions and the development of evidencebased policy and/or interventions in the OH AMR domains.

Potential outcome indicators for SO3:

- Data sharing and (re)utilisation of resources
 - Number and type of R&I project outcomes (data, technical tools, protocols and guidelines) and resources generated and made available as FAIR in open platforms
 - Number of projects funded utilising both new and existing data/research resources or platforms/infrastructures
 - Number of projects providing data in recognised repositories
 - Number of projects funded developing links between data/research resources or platforms/infrastructures across sectors and disciplines
- Knowledge translation for innovations and implementation
 - Engagement of projects with industry, regulators, policymakers, social science sectors, patient and other end-user organisations for innovation and translation of research results
 - Share of projects with R&I outcomes adopted for implementation of solutions/products and/or as base for creation of (start-up) companies
 - Number of products/developments transitioning to the market or are at advanced TRL maturity in pipeline development
 - Number and types of R&I outputs that are disseminated in a format accessible for end users and citizens at large (e.g. videos, infographics, summaries, social media campaigns)

Operational objectives

The above mentioned general and specific objectives have been transposed in four Operational Objectives.

OO1. Coordination and prioritisation of R&I activities to avoid fragmentation and duplication of efforts between and across sectors for stronger OH AMR global cooperation

Action 1. Stimulate collaborative activities between EU and Member States, associated countries, LMICs and other international initiatives to increase commitment and investment.

Action 2. Provide regular/periodic platforms for information exchange with other partnerships/initiatives and multiple groups of sectoral and disciplinary stakeholders within and outside Europe to identify prioritised research and innovation objectives targeted to the actual needs (challenge-driven) of societies.

Action 3. Establish governance mechanisms and platforms for regular, periodic cross sectoral and cross disciplinary collaborations between funders and a broad range of stakeholders to capitalise on synergies and continue development of the joint SRIA/Roadmap of Actions.

Potential output indicators for OO1:

- Global stakeholder engagement
 - Establishment of platform among countries (policymaker, regulator), funders/donors, sectoral researchers and industry stakeholders within and outside Europe
 - Membership growth (number and diversity of funding organisations)
 - Joint investment committed for OH AMR R&I actions
 - Diversity of engaged stakeholders (e.g. public, private, geographical and sectoral diversity)
 - Participation of Widening countries and LMICs
- Joint synergistic activities
 - Number and type of activities with other HE partnerships
 - Number and type of activities and social science and science partnerships facilitated within and around Europe
 - Number of partnerships established between Europe-LMIC country research management bodies/ AMR programs for establishing an environment for cocreating/ exchanges in R&I or pilot in different resource settings
 - Number of other global collaborations on transversal activities to promote collective mutual learning and exchange of knowledge and solutions between sectors
 - Continued development of the joint SRIA and roadmap of actions

OO2. Develop joint R&I actions to support career and capacity building programmes and to facilitate sharing and (re)use of data and research resource platforms for global societal benefit

Action 1. Support mobility measures and capacity building programmes utilising various funding instruments.

Action 2. Create links and synergies between research resource platforms in and among sciences and social sciences for pilot and use in different sectors and settings.

Action 3. Facilitate and support sharing and (re-)use of data and research resources.

Potential output indicators for OO2:

- Upskilled researchers and increased research capacity
 - Share of research and innovation partners in funded projects representing different types of organisations (academic, industry, public health, civil society etc.)
 - Number of Early Career Researchers funded in research projects as well as undertaking mobility programmes, mentoring, training, and benefitting from capacity and career building programmes
 - Number of researchers funded from Widening countries
 - Number of researchers funded from LMICs
 - Knowledge transfer activities targeted to LMICs and widening countries
 - Number and type of activities facilitating and/or supporting sharing and (re)use of AMR data/research resources

OO3. Increase joint support of R&I actions to prevent and treat drug resistant infections, improved surveillance, diagnosis and control of the spread of resistant microorganisms with integration of social sciences, interdisciplinary research and co-creation by end-users that add value to society and planetary health

This objective will reflect and encompass the R&I actions defined in the EUP OH AMR Roadmap of actions (TBD) including annual co-funded calls for proposals of research and innovation projects. OO3 will be further refined with detailed descriptions of actions and output indicators corresponding to the prioritised research and innovation objectives selected for calls and other activities.

Action 1. Support cutting edge research with increased funding, new modalities and approaches and strengthen trans- and interdisciplinary and inter-sectoral research and through annual joint transnational calls

Action 2. Support translational research for the development of (challenge-driven) innovative solutions

Action 3. Integrate cross-cutting issues including socio-economic and global aspects, implementation science and innovation in R&I actions (e.g. support project interaction with medicine regulators to obtain support and guidance at early-stage/planning of projects).

Potential output indicators for OO3:

- Joint activities and actions addressing prioritised OH AMR R&I objectives
 - Types and share of R&I activities (e.g. joint transnational calls and other activities) in SRIA thematic areas (Therapeutics, Diagnostics, Surveillance, Transmission and Evolution, Interventions for prevention and mitigation of AMR)
 - Share of projects integrating cross-cutting issues including socio-economic and global aspects with One Health perspective
 - Number of transnational projects and networks funded
 - Number of projects which includes industry/SME with increased TRL maturity
 - Number and share of projects where citizens and end-users contribute to the cocreation of R&I content
 - Number and type of activities for testing, validation and development of innovation and translation of research results (e.g., through specific implementation research/stewardship/intervention trial calls and other activities)

OO4. Support dissemination and exploration strategies for research-healthcarepatient-policy-industry-community engagement to respond to actual needs of the society

Action 1. Activities and events to strengthen the dialogue between the scientific community and national, EU and international AMR policy decision-making and implementation bodies to support creation of policies and programmes informed by research findings

Action 2. Activities and tools to ensure efficient uptake of innovative solutions, such as events to support exchange between researchers, regulators, SMEs, industry, policy-makers, health care providers and end-users for engagement at early stages of research projects as well as to disseminate and exploit knowledge and research results adapt solutions and increase the awareness of the AMR challenge.

Potential output indicators for OO4:

- Community engagement and knowledge dissemination to end-users
 - Number of activities on science policy interface, science communication, citizen science etc involving researchers and end-users.
 - Number and type of early engagement and dissemination activities between researchers, industry, policymakers, regulators and other end-user organisations
 - Number and type of stakeholders engaged in early engagement and dissemination activities (industry, regulators, policymakers, civil society) and other end-users

GO1

Strengthen resilience to the AMR threat in Europe and beyond

GO2

Enhance evidence-based policy measures and innovative solutions to prevent, detect, control, and treat drug-resistant infections in humans

SO1

Enhance global and European synergy, multi-sectoral collaboration, and alignment of joint strategic OH AMR R&I policies to break silos

SO2

Boost research & innovation to enhance knowledge and develop solutions to understand, prevent, and tackle AMR

SO3

Enhance knowledge translation and uptake of research and innovations into solutions and evidence-based policy

001

Coordination and prioritisation of R&I activities to avoid fragmentation and duplication of efforts between and across sectors for stronger OH AMR global cooperation

002

Develop joint R&I actions to support career and capacity building programmes and to facilitate sharing and (re)use of data and research resource platforms for global societal benefit

003

Increased joint support of R&I actions to prevent and treat drug resistant infections, improved surveillance, diagnosis and control of the spread of resistant microorganisms with integration of social sciences, interdisciplinary research and co-creation by end-users that add value to society and planetary health

004

Support dissemination and exploration strategies for research-healthcare-patientpolicy-industry-community engagement to respond to actual needs of the society

Figure 2. General, Specific and Operational objectives of the EUP OH AMR. All objectives are interconnected and thus, each OO contributes to several SOs and each SO contributes to both GOs.

Research and Innovation Objectives

The mission of the EUP OH AMR is to boost OH, interdisciplinary, intersectoral R&I to address the AMR challenges. To achieve this mission, a joint research programme is being developed, focusing on three overarching aims:

- Improve the understanding of AMR
- Prevent the emergence and spread of AMR
- Tackle AMR by developing innovative treatments solutions, as well as technologies and strategies to reduce AMR in contaminated environments

The R&I Objectives define the scientific perimeter of the EUP OH AMR and will provide the framework to develop future transnational calls and activities. The objectives are structured under five non-mutually exclusive thematic areas: Therapeutics, Diagnostics, Surveillance, Transmission and Evolution, and Interventions for prevention and mitigation. The objectives have been developed taking into account the One Health dimension of AMR, as well as four cross-cutting themes: the role of socio-economic factors in the emergence and spread of AMR, the importance to translate research results into innovation, the role of implementation science to facilitate the translation and uptake of innovative solutions in real word settings, and the global challenges posed by AMR (Figure 3).



Figure 3. The five thematic areas and the four cross-cutting themes.

Within each of the five thematic areas, the R&I objectives have been logically organised (from basic research to more applied science and policy). These objectives are in alignment with those of the WHO Global AMR research agenda in the human health

sector and the UN One Health priority research agenda (draft versions). These objectives also support the priorities identified in the EU Action Plan on AMR by:

- improving the current surveillance strategies and methods for AMR (Objective 2.1 of the EU Action Plan)
- supporting the development of new therapeutics, new alternatives and novel diagnostics (Objective 2.2 and 2.4 of the EU Action Plan)
- investigating the role of environment in AMR emergence and spread (objective 2.6 of the EU Action Plan)
- providing evidence to guide preventive interventions (Objective 2.1 and 2.6 of the EU Action Plan)
- contributing to the vaccination strategy of EU in an AMR context (objective 2.3 of the EU Action Plan).
- to a smaller extent contributing to support of sustainable and equitable accessibility to antimicrobials by supporting analyses regarding antimicrobial production issues and along the supply chain, by proposing potential solutions to overcome those barriers (Objective 2.5 of the EU Action Plan).

The EUP OH AMR R&I objectives also integrate the priorities of the Horizon Europe programme, such as the strengthening of the EU innovation pipeline, the development of emerging digital technologies, the protection of the EU ecosystems from chemical pollution, and the resilience of the European society in front of the AMR challenge. Apart from contributing to the EU Action Plan on AMR and the strategies of Horizon Europe, other world-wide challenges and opportunities, such as climate change, green transition and artificial intelligence, have also been integrated in the present R&I objectives.

The following section provides a concise description of the R&I objectives identified for the thematic areas, as well as of the cross-cutting themes. A detailed version of the Research and Innovation Objectives is provided at the EUP OH AMR website²⁵.

²⁵ Research and Innovation Objectives of the EUP

Therapeutics

The general aim of the Therapeutics thematic area is to discover new therapeutic targets, develop new antimicrobial agents and therapeutic alternatives, and improve existing antimicrobials and treatment regimens.

The goal of this priority area is to improve current antimicrobial therapies and to enhance the discovery, preclinical and early clinical development of novel antimicrobials and treatment strategies. This includes the repurposing of existing drugs as well as the optimisation of drug delivery and treatment protocols. In addition, this priority area aims to propose solutions to accelerate the entry of novel drugs and innovative treatment protocols to the market by developing preclinical models, by proposing innovative regulatory procedures, by developing alternative socio-economic models to stimulate drug development, drug production and drug supply while ensuring a high level of acceptability to endusers, appropriate use through antimicrobial stewardship and minimal impact on the environment.

How therapeutics will contribute to the prevention and mitigation of AMR

The progressive ineffectiveness of the current human therapies will inexorably lead to an immediate increase in the number of human deaths, while the possible banning of antimicrobials to treat animal and plant infections would likely lead to a decrease in food production, and increase hunger worldwide, unless new approaches are investigated and applied to treat infectious diseases. The development of new therapeutic solutions, including alternatives to antimicrobials, or the improvement of current ones is urgently needed.

Needs, gaps and challenges in therapeutics

The number of recently approved antibiotics is inadequate and fall short of what is required to mitigate the challenge of AMR. For this reason, the effectiveness of the current treatment solutions should be enhanced, while new antimicrobials and alternatives to antimicrobials should be discovered and developed to address the current clinical needs in human and veterinary medicine. The therapeutic pipeline is hampered by different barriers. These barriers can be either economic, logistic, legal, structural, behavioural or socio-psychological. Research is needed to characterise these barriers and to propose solutions to overcome them. While many treatment protocols have been established empirically, the current treatment protocols should be rationalised in terms of dose, administration frequency and duration in order to decrease the risk of AMR development in both humans and animals. Since the production and consumption of antimicrobials have an impact on the environment, research should also identify strategies to minimise this impact. Research is also needed to assess the risk of cross-resistance to antimicrobials used in different One Health sectors to aid development of evidence-based policies and guidelines aimed at rationalising the use of antimicrobials in animals and agriculture.

R&I objectives within the therapeutic area

- 1. Identify new targets and develop new antimicrobials, novel alternatives to antimicrobials, and improved delivery methods
- 2. Improve the efficacy of existing antimicrobials and reduce the risk of resistance (improved PK/PD, drug repurposing, combination therapies)
- 3. Facilitate the transfer of new antimicrobial agents or novel therapeutic strategies to clinics (*in-vitro*/ *in-vivo* models, calculation of new end-points, personalised therapies, relative importance of the environmental cost during antimicrobial prescription)
- 4. Develop strategies to minimise the structural and economic barriers to research, development, availability and access to new therapies and alternative therapeutic strategies

Please see the long version of the Research and Innovation Objectives²⁶ for more details

²⁶ <u>Research and Innovation Objectives of the EUP OH AMR</u>

Diagnostics

The general aim of the Diagnostics thematic area is development and improvement of diagnostics to support the use of antimicrobials and alternatives to antimicrobials.

The goal of this priority area is to stimulate the design, development, evaluation and implementation of diagnostics to ensure appropriate use of antimicrobials in the treatment infections. Appropriate diagnostic tools can also be used to support interventions to tackle AMR, including infection prevention and control, and antimicrobial stewardship. In infectious diseases, diagnostics are most commonly used to identify which pathogen(s) are causing symptoms. Diagnostics are typically used to identify a disease or its cause, and are considered in all One Health settings, including the emerging topic of environmental diagnostics. Of particular interest are the diagnostics of infections caused by antimicrobial-resistant pathogens of clinical importance. Diagnostic tests allowing rapid detection of drug susceptibility are required to support rational clinical decision-making and stewardship, leading to a more targeted and sustainable use of antimicrobials in all One Health settings.

How diagnostics will contribute to the prevention and mitigation of AMR

Diagnostics are tools that aim to detect and characterise microorganisms (species, strain, and their antimicrobial susceptibility) and that can be used to guide antimicrobial prescription to treat infection or to collect data for AMR surveillance. In the absence of proper diagnostics tests, empirical treatments are prescribed, leading to inappropriate use of antimicrobials (e.g. use of antibiotics for a viral infection), or to the prescription of less effective antimicrobials (e.g. in case of AMR). When diagnostic tests are co-developed with novel antimicrobials, diagnostic tests can also facilitate the enrolment of patients during clinical trials. Tools developed for diagnostic purposes can in some cases also be used for detection of AMR in non-pathogenic microorganisms, and diagnostic data can feed into surveillance. Thus, development of new and improved diagnostics is vital.

Needs, gaps and challenges in diagnostics

New rapid, cost-effective and reliable diagnostic tests and methods are needed for identification and susceptibility testing of key pathogens, especially point of care diagnostics that can be performed *on-site* to guide antimicrobial prescription in both human, veterinary medicine and agriculture. The performance, rapidity, feasibility and cost-effectiveness of the existing diagnostics should be improved. Since existing diagnostics are under-used by drug prescribers, identification and characterisation of the barriers preventing their use is needed. In addition, research in social and behavioural science should also propose solutions to overcome these barriers. Research showing the impact of diagnostic tests on clinical outcomes, on AMR spread and on AMR

management costs is needed to convince local authorities to recommend the use of diagnostics.

Research and innovation objectives within the diagnostics area

- 1. Discover, design, develop and evaluate new diagnostics and improve the effectiveness of existing ones.
- 2. Evaluate field performance, feasibility, and impact of diagnostics
- 3. Identify and overcome barriers to implementation, acceptance, and use of diagnostics

Please see the long version of the Research and Innovation Objectives²⁷ for more details

²⁷ <u>Research and Innovation Objectives of the EUP OH AMR</u>

Surveillance

The general aim of the Surveillance thematic area is to optimise surveillance systems to understand the drivers and burden of AMR in a One Health perspective and support decision making at all levels.

The goal of this priority area is to strengthen the research on surveillance systems, methods, interpretative guidelines, and communication tools to optimise the surveillance of AMR and antimicrobial use and consumption (AMU/AMC), using a One Health approach, in order to inform the prevention and treatment of infections in humans, animals and crops. Surveillance may also serve as an indicator to assess the impact of interventions to mitigate AMR and inappropriate AMU in humans, animals, crops and the environment.

How surveillance will contribute to the prevention and mitigation of AMR

Surveillance of AMR involves continuous, systematic collection, analysis, interpretation and communication of data to monitor and act on the level of AMR and antimicrobial use (AMU). Surveillance is fundamental to estimate the burden of AMR, and to raise the public awareness of AMR risks. AMR surveillance will also guide the prescription of antimicrobials, for example when adequate diagnostic testing is missing. It acts as an early-warning signal to implement targeted interventions, provide data to better understand the transmission, directionality and risk of the spread of AMR, and produce evidence to evaluate the effect of an intervention. For those reasons, the improvement of the current surveillance strategies is fundamental.

Needs, gaps and challenges in surveillance

Research should identify the samples and data to be collected for an effective surveillance. Even where substantial surveillance data are already available, their heterogeneity, in terms of nature and quality and sustainability, constitute a real issue for optimising their use. Research is needed to prioritise and/or harmonise the indicators (microbial species and AMR/AMU data to collect), as well as the place and time to collect them. Research is needed to define standardised and harmonised sampling, analysis, interpretation and communication protocols, to allow comparison of the data across different One Health sectors, including wildlife, and across different regions of the world. Surveillance data should be integrated and analysed together with other types of data, such as meta-data, epidemiological data or social data, for which informatic tools should be developed. Research is also needed to propose strategies and tools to facilitate and encourage data collection, data storage, data sharing, dissemination, communication, and the involvement of the end-users from data collection to data use. Economic studies should demonstrate the cost-effectiveness of different strategies for surveillance, and propose strategies/ frameworks, for quality assured AMR surveillance both in LMICs and in high income countries. Economic or social barriers preventing the development of surveillance should be identified, and solutions should be proposed.

Research and innovation objectives within the surveillance area

- 1. Optimise, standardise, and harmonise AMR and antimicrobial use/antimicrobial consumption surveillance protocols, to achieve or improve cross-compatibility of surveillance systems
- 2. Identify reservoirs and transmission pathways of AMR in the different One Health settings to predict the risk of potential outbreaks and guide preventive actions
- 3. Optimise the use of surveillance data to estimate the burden of resistance, assess the impact of interventions, and enable policy and practice action
- 4. Develop strategies and methods to promote the exchange, interpretation and communication of surveillance data

Please see the long version of the Research and Innovation Objectives²⁸ for more details

²⁸ <u>Research and Innovation Objectives of the EUP OH AMR</u>

The general aim of the Transmission & Evolution thematic area is to understand and prevent the transmission and evolution of antimicrobial resistance in a One Health context.

The goal of this priority area is to improve the understanding of both the evolution and the physical transmission of microorganisms resistant to antimicrobials. This includes exploring mechanisms involved in gene mobilization, transfer of resistance, mutations, epigenetic modifications, physical transmission and maintenance of resistance under various conditions. It also includes understanding drivers of such processes, all the way from chemical and molecular drivers to socio-economic and behavioural ones. Identifying AMR reservoirs, evolutionary arenas and providing evidence behind the directionality and scale of AMR transmission through various pathways is key. A One Health approach that considers the evolution and transmission of microorganisms and their antimicrobial resistance determinants, within and between humans, animals and the environment, is needed to fully address the complexity of the challenge. Together, this will help to design effective interventions adapted to different settings and geographical variations.

How better understanding of AMR transmission and evolution will contribute to the prevention of AMR

Rapid preventive actions need to be implemented to avert the threat of AMR. Such actions include, but are not limited to, the reduction of AMR selective factors in the environment, the restriction of unnecessary AMU, and the control of human or animal exposure to contaminated water. Those actions are difficult to accept by the targeted end-users without strong rationale, and strong evidence of effectiveness, as they often come with an associated cost. Understanding the mechanisms involved in the transmission and evolution of AMR will help public health authorities to design efficient preventive interventions. In addition, identifying interventions with proven effects will be a mark of success that will encourage public health authorities to adopt and scale-up the interventions. Furthermore, a better understanding of transmission and evolution mechanisms of AMR could help to identify new drug targets, or improve the existing drugs.

Needs, gaps and challenges in transmission and evolution

Research is needed to identify and characterise sources and reservoirs of AMR, and to understand different drivers for the evolution and transmission of AMR. Considering the different nature of potential drivers (such as molecular, chemical, social, and societal), modelling schemes should be developed. Once drivers and transmission routes are identified, research should contribute to design specific preventive interventions to limit AMR spread. Although the massive use of antimicrobials in the medical and agricultural sector have been shown to be associated with increased AMR in the environment, it remains still unclear how, and to which extent, AMR in animals and in the environment contribute to AMR risk in humans. New evidence on the directionality of transmission should be provided by research. Directionality of transmission between non-pathogenic (such as environmental microbiota) to pathogenic strains should also be investigated. Research should also identify the direct or indirect consequences of the climate changes on AMR spread (e.g. through migration of population and modification of AMR reservoirs).

Research and innovation objectives of the Partnership within the area of transmission and evolution

- 1. Identify the critical environments, mechanisms and drivers involved in the emergence of successful antimicrobial-resistant genotypes
- 2. Understand the directionality and scale of transmission of resistant microorganisms in and between humans, animals, plants and the environment, and identify critical routes and underlying drivers of transmission
- 3. Identify, design and evaluate technical and social interventions to control the emergence and transmission of resistance, based on an understanding of the relative importance of different sources and drivers

Please see the long version of the Research and Innovation Objectives²⁹ for more details

²⁹ <u>Research and Innovation Objectives of the EUP OH AMR</u>

The general aim of the 'intervention for prevention and mitigation' thematic area is to develop and innovate approaches to prevent and mitigate the emergence and spread of AMR, across One Health.

The goal of this priority area is to investigate and develop innovative approaches/tools for responsible antimicrobial use, prevention and control of infections, surface decontamination, improved access to antimicrobials and quality diagnostics, development of newer vaccines, improved access to water, sanitation, and hygiene, antimicrobial recycling, better agricultural practices, and strengthening health systems. It would also entail identification of barriers during the uptake and scale up of the innovative approaches/tools as well as evaluation of their cost effectiveness. The interventions that would be designed and piloted may be either technical or social and can target the evolution of AMR at any level (transmission, reservoirs, drivers etc). As reinforced by the COVID-19 pandemic, interventions should be adapted to different geographical and social contexts to effectively tackle AMR globally.

How interventions will contribute to the prevention and mitigation of AMR

AMR constitutes a serious threat to human health in absence of rapid actions. Hence interventions are needed to control and, if possible, reverse the progression of AMR. Those interventions could be divided into two categories: prevention to avoid the emergence and spread of AMR before it reaches a critical threshold, and mitigation when AMR has already reached a significant level. Interventions include a large variety of actions, such as the use of technological tools, the adoption of laws, regulation and protocols, the creation of economic incentives, or structural reorganisation. On one hand, the public health authorities and the national ministries are responsible for the implementation of interventions while on the other hand the researchers are responsible for identifying the needs and opportunities for interventions, and for showing the effectiveness of the interventions in the fight against AMR.

Needs, gaps and challenges in the intervention area

Research is needed to design, develop and improve tools, techniques and recommendations that would contribute to prevent and mitigate AMR. Research should establish a sound rationale to design pilot interventions (such as interventions targeted at specific transmission routes or specific settings), as well as to prove their effectiveness through defining metrics and measures. Research is also needed to identify the barriers preventing the uptake of a proven intervention and its implementation and to develop strategies to overcome these barriers. Aspects related to researching the cost-effectiveness of an intervention as well as its acceptability and adaptability to different settings and local contexts is crucial.

Research and innovation objectives of the Partnership within the intervention area

- 1. Evaluate opportunities, acceptability and feasibility of interventions in different countries/local contexts
- 2. Design and test interventions based on new and existing evidence and new technologies to prevent and mitigate AMR
- 3. Estimate the impact and cost-effectiveness of new interventions and prevention strategies
- 4. Identify the parameters that should be considered to adapt a successful intervention to different settings, or to scale up interventions

Please see the long version of the Research and Innovation Objectives³⁰ for more details

³⁰ Research and Innovation Objectives of the EUP OH AMR

Cross-cutting themes

Considering the complexity of AMR, some cross-cutting themes will be applicable to all of the thematic areas. These specific themes will be considered in the design, development and implementation of the dedicated R&I activities in each area.

One Health approach

As highlighted in the introduction, One Health indicates that microorganisms, and the genes they carry, can move between humans, animals, plants and the external environment. Hence, understanding and managing evolution and transmission of AMR often requires considerations of processes in multiple sectors. Indeed, drug resistant microorganisms may spread between animals, plants and humans through food consumption, air or through direct contact. Antimicrobials from human, animal and crop use, as well as resistant microbes and their genetic material, can also contaminate the environment and wildlife via wastewater, animal manure, composted crop materials, dust or insects that populate farms. Besides being a threat to human health, AMR complicates the prevention and treatment of infections in animals, which threatens both animal welfare and food production. Decreasing the tremendous impact of AMR on human health thus requires a better understanding of the evolution and transmission of resistance between the different OH sectors as well as solutions to prevent this. The need for a One Health approach is widely accepted by the AMR community, but cooperation and collaboration between different disciplines and groups still remains a major challenge.

The EUP OH AMR will pursue and reinforce the initiatives from the UN Quadripartite, JPIAMR, EJP One Health and JAMRAI to use a One Health approach to curb AMR, by strengthening the links between different sectors and stakeholders. For example, the EUP OH AMR intends to support the development of methods that will facilitate the integration of surveillance data on AMR, AMU and AMC collected in the different One Health settings. The EUP OH AMR also aims to investigate how the monitoring of resistant bacteria and genes in humans, environment, agriculture and food production can be improved to inform AMU. Furthermore, the EUP OH AMR intends to propose technical and social interventions aimed at decreasing the release of antimicrobials to the environment from different sources. While the use of antimicrobials in the human health sector and in agriculture has a clear impact on the concentration of antimicrobials in the environment, the consequence of such pollution on AMR evolution and on the risks to human health are still unclear. By investigating the directionality of transmission in and between the One Health sectors, EUP OH AMR will guide preventive measures to be implemented by public health authorities, health care, farmers and industry. Evidence of cross-resistance between different antimicrobials and different One Health sectors may also provide guidance to health authorities regarding the list of antimicrobials to be safeguarded for specific pathogens, or for human use only.

Socio-economic sciences, the humanities and implementation science

Social sciences are positioned to respond to AMR as a problem that manifests in different ways in different places, reflecting the economic, social, behavioural and environmental contexts and challenges of different countries with diverse socioeconomic settings. It is, therefore, crucial to include the perspectives of social sciences, alongside the life sciences, at all stages of the R&I planning and implementation. The plurality of social science disciplines can offer an understanding of AMR, not only as a biological phenomenon but also how it is affected by social issues, such as behaviour, law, culture, ethics, and management science. EUP OH AMR will therefore encourage multi- and inter-disciplinary research across the social and life sciences to contribute to the understanding of the biosocial dynamics of AMR from a One Health perspective.

Intervention research and implementation science form part of a continuum, which seeks to improve the uptake of research in various forms. While interventions (including Therapeutics and Diagnostics) are often developed and evaluated in controlled environments or in laboratories, the EUP OH AMR will integrate implementation science to apply methods and interventions in real-world settings. This will include the study of methods to promote the adoption, uptake and integration of evidence-based practices and interventions for health impacts. The main readouts would be acceptability, adoption, cost-effectiveness, coverage, and sustainability. The EUP OH AMR will also encourage the involvement of key stakeholders at early stages of research planning and the application of implementation science to facilitate the uptake of R&I results and to guide policy development.

Innovation

Innovation is critical in the field of therapeutics, diagnostics and surveillance as well as for intervention and prevention of AMR, where, e.g. the creation of new technologies could be utilised to decrease drug resistance in AMR hotspots. While research is urgently needed to provide new solutions to curb AMR, the translation from research to innovation remains particularly challenging. In addition to the classical barriers to innovation, AMR research landscape faces additional challenges when it comes to innovation, such as the low return on investment in developing antimicrobials. Innovation will benefit from the recent progress made in computational science and artificial intelligence. Big data mining and cloud computing will facilitate storage, analysis and exchange of surveillance data. Artificial intelligence will benefit the realtime integration of surveillance and diagnostics data that, in turn, will support the development of new applications and software to facilitate clinical decision-making. In therapeutics, bioinformatic tools will assist the design of new therapeutic molecules based on the 3D structure of the cellular targets. The development of in silico methods and in vitro models (such as organoids) replicating specific or multiple pathophysiological disease states should support the prediction of the effectiveness and toxicity of candidate drugs. Such developments could maximise the chance of a lead molecule entering a clinical trial, and refine, reduce and/or replace the use of animal models. Considering that individual behaviour or structural components constitute important drivers of AMR, the EUP OH AMR will also support the development of social innovation, such as the development of new organisation models for agriculture or healthcare, new supply chain models for antimicrobials, or new economic models that rewards drug manufacturers with good pollution control.

The EUP OH AMR thus aims to address the innovation priorities in each of the thematic areas. In addition, specific actions will be undertaken during the lifetime of the EUP OH AMR to encourage and facilitate the uptake of research results by innovators (measures encouraging the participation of private companies in funded projects, activities favouring the exchange of results and the uptake of research results among researchers and industry partners) for further development.

The global challenges of AMR

As illustrated by the COVID-19 pandemic, pathogens circulate without recognising borders, and travels and trade obviously constitute important drivers of AMR spread. EUP OH AMR will contribute to identify the critical steps favouring AMR global transmission Limiting the circulation of the microorganisms or their genes is elusive. For this reason, efforts to mitigate AMR should be coordinated across countries and regions. In this context, the preparation of this SRIA has been done in alignment with the development of other AMR research strategies, such as the WHO Global research agenda for AMR in the Human Health sector, the UN Quadripartite One Health Priority Research Agenda for AMR and the EU OH Action plan against AMR. The identification of R&I objectives for the EUP OH AMR was done in alignment with these organisations, in order to ensure synergy and complementarity. In this context, specific attention has been paid to covering the R&I priorities of both high-income countries (HICs) as well LMICs. The latter are particularly vulnerable to the threat of AMR. This is due to limited surveillance and diagnostic opportunities, less-controlled use of antimicrobials in both humans, animals and agriculture, inadequate infection prevention control measures, insufficient hygiene control, often rapidly growing meat and fish production, an overall greater infection burden, inferior infrastructure for managing human and animal waste streams and limited access to expensive, second-line or third-line antibiotics. The R&I objectives address how the local contexts (prevalence of resistance genes, different infrastructures, laws, cultures, climates, societal frameworks, health systems, access to care, and resources) should be considered while developing new interventions, new treatments or new diagnostics.

Foreseen activities and portfolio of funding instruments

The core activities of the EUP OH AMR will be to support R&I, strengthen capacity building (including cross-sectoral), facilitate networking, and create channels for cross-sectoral, cross-disciplinary interactions. A portfolio of potential funding instruments is currently under development to implement transnational R&I projects, other actions, and transversal activities.

Portfolio of funding instruments

R&I funding activities will be the main instrument to achieve the ambitious objectives of the EUP OH AMR, to close current knowledge gaps, break existing silos, and use challenge-driven approach to strive the translation of knowledge and research results on AMR into practices and innovations.

The portfolio of funding instruments will include modules for grant funding and modules for capacity building.

Grant funding modules

The grant funding modules will include funding for R&I projects as well a funding for research networks.

Grants for research projects are expected to be provided to transnational R&I projects of different maturity levels dependent on the need and priority of the calls (Figure 4). This will include:

- **Basic research projects** addressing fundamental research questions and bringing new knowledge,
- *Innovation research projects* that are challenge-driven, for research translation to technological development and innovations
- Implementation research projects testing evidence-based solutions and interventions in real world contexts with the possibility to sustainable scale-up

Grants for research networks are foreseen to use two modules to support networks using different implementation approaches:

- **Knowledge synthesis** is a proposed grant funding module using the sand pit approach intended to support networking and capacity building for contextualising and integrating research studies within the existing knowledge on the topic. The working groups will be formed by researchers through brokerage events organised by the EUP OH AMR, to work on systematic reviews on targeted topics, white papers, prospective views, guidelines, and/or best practice frameworks to identify key questions to be addressed or identify potential solutions to overcome barriers within the One Health communities.
- **Knowledge & resource hubs** is a proposed grant funding module for creation of networks between leading scientists, practitioners, stakeholders, and commercial developers and experts and form one or more knowledge or resource hubs for data,

tools, methods, practices in relation to the call topic. Funded networks would work on development of knowledge/data-sharing platforms and toolboxes to create cross-sectoral and cross-disciplinary collaboration.



Figure 4. Grant funding modules.

Capacity building modules

Capacity building modules include support for complementary elements including capacity building of early career researchers (ECRs), researchers from LMICs, widening countries and the support that the EUP OH AMR will provide for potential applicants, grantees, broader community and relevant stakeholders (Figure 5).



Figure 5. Capacity building modules.

The following aspects will (when relevant) be taken into consideration while choosing the module(s) for joint annual transnational calls to support AMR R&I as well as capacity building:

- Interdisciplinarity of projects, including social, behavioural sciences and humanities in AMR topic
- Actions to create science-policy interface, that would facilitate the knowledge exchange between scientific experts and policy makers
- Engagement and/or information sharing with regulators, other relevant stakeholders and end-users, including patient groups and civil society
- Intersectoral uptake of existing and newly created knowledge, including elements to strengthen cross-sectoral capacity and collaboration across sectors, promote learning and exchange between sectors for the collective generation of knowledge and solutions
- Harmonisation, reuse and sharing of data, sharing resources and infrastructure
- Strengthen dissemination on AMR problematics in scientific literature and communication to the society, inform and engage general public and citizens
- Context-specific research, relevant to different settings and geographical locations
- Research results uptake and translation into products, innovations, guidelines, policy and practice, career development in the industry

The funding organisations of EUP OH AMR will discuss about the possible design models of the joint transnational calls (JTCs). The preliminary proposed concept, that is under discussion, comprises the use of more than one grant funding module in a single transnational call including necessary capacity building elements. The call topics will be defined and prioritized in the timeframe of the EUP OH AMR according to the SRIA and the R&I objectives. All five thematic areas and horizontal cross-cutting themes will be reflected in the future R&I actions of the EUP OH AMR. Depending on the topic of the call and its focal areas, proposals from various research disciplines will be expected, such as social sciences (including economics), microbiology, pharmacology, chemistry, bioinformatics, epidemiology, data science and implementation science etc.

Transversal activities

The EUP OH AMR plan to perform transversal activities that are complementary and synergistic with the funding activities, to reach the main objectives: breaking silos, support networking, increased research capacity, training and mobility, facilitating data sharing, facilitating translation, support science-informed policy development. These activities will mainly be performed by the EUP OH AMR partners.

Transversal activities of the EUP OH AMR partners are also considered to strengthen the impact of funded projects and networks, as well as part of the capacity building portfolio. The EUP OH AMR will support funded research projects and networks throughout the entire life-cycle of the project through various phases from application to implementation and include end-of-grant actions in the form of information events, workshops, brokerage events, knowledge user engagement guidelines, and services for knowledge translation etc.

Examples of potential activities (non-exclusive list):

- Communication efforts to ensure effective information exchange between scientific disciplines and societal sectors, such as webinars and conferences with interdisciplinary and intersectoral audiences, newsletters with briefs and updates, social media campaigns, targeted updates on transversal themes and topics and exchange with other communications platforms to optimise outreach and dissemination of information.
- Support of transnational innovation cooperation through training, workshops and networking events between researchers and SMEs/industry
- Support to evidence-based policy by close contact with EU and national policymakers and regulatory agencies, and dissemination of key research outcomes through alignment with outcomes from other initiatives
- Events to engage with relevant stakeholder and end-users (health care, patient organisations, civil society, food supply chain providers etc.) throughout the life-cycle of the R&I projects (including co-creation)
- Open science and data management, including support for FAIR (Findable, Accessible, Interoperable and Reusable) and harmonised data management, integration of EU and national data and information infrastructures and encouragement of publishing in Open Research Europe
- Facilitation of access to and harmonised use of available research infrastructures
- Conferences and/or topic specific workshops for funded projects to enhance research capacity and networking
- Interaction and alignment with other partnerships, initiatives and stakeholders (please see some examples on pages 38-42)

Synergies and engagement with other partnerships, initiatives and stakeholders

The EUP OH AMR will seek synergies with other partnerships and funding initiatives in order to maximise the outcomes. The mode of interactions for each partnership/initiative will be further defined in a later version of the SRIA, but will be conducted at three different levels of engagement:

- Inform: The main purpose of the interaction will be to communicate about ongoing and future activities and disseminate the results. This will ensure optimised uptake and reach of any activity of the EUP OH AMR. We also expect reciprocal exchanges to keep us informed about the activities of the interacting partners to ensure that duplication of efforts and gaps in the R&I landscape are avoided.
- Consult: The main purpose of the interaction will be to consult the interacting partners to align, seek synergies and receive expert opinion and feedback on planned activities. In addition, sharing of best practices between the partners will support efficient and effective implementation.
- Collaborate: This type of interaction demands the highest level of engagement and will involve commitment to diverse joint activities, ranging from synergy of transnational calls, joint workshops and training activities. This will result in optimisation and sharing of resources between the partners.

A set of criteria has been designed to identify relevant initiatives, including relevance to the EUP OH AMR objectives, complementarity and added value. Based on these criteria, a number of relevant European partnerships and other initiatives have been identified (see Tables 1-3). After initial discussions with these partnerships, another set of criteria will be used to identify their level of engagement depending on needs, availability of resources, feasibility, geographical coverage, etc.

Table 4	Delevent	F	De utur e unde luce		F	Church and A	/	۰.
lable 1.	Relevant	European	Partnersnips	s within Horizon	Europe	Cluster 1	Health).

Partnership	Goals of the partnership (brief description)
<u>Global Health</u> <u>European &</u> <u>Developing</u> <u>Countries Clinical</u> <u>Trials Joint</u> <u>Undertaking, (GH</u> <u>EDCTP 3-JU)</u>	EDCTP3 will support international collaborations accelerating the clinical evaluation and implementation of interventions against poverty-related infectious diseases including the neglected ones affecting sub-Saharan Africa, with a particular focus on late stage clinical development and vulnerable groups. By building research capacity, it will also enhance the ability of sub-Saharan African countries to identify and respond to key infectious disease health challenges.
<u>Personalised</u> <u>Medicine,</u> (EP PerMed)	The vision of EP PerMed is to improve health outcomes within sustainable healthcare systems through research, and the development and implementation of personalised medicine approaches for the benefit of patients, citizens and society. Personalised medicine will shift to approaches for earlier and more precise diagnosis, to predict predisposition to disease and select personalised therapies that achieve the best outcomes.
ERA for Health Research, (ERA4Health)	The goals of ERA4Health are better quality of life and care, transformation of public health care systems and strengthened disease prevention. ERA4Health will support relevant medical research including clinical fields and intervention areas (prevention, diagnosis, treatment), improve the utilisation of existing health technologies in clinical practice, build capacity, in particular in conducting Investigator Initiated Clinical Studies at EU scale and implement and advance the practice of RRI across the breadth of the programme.
Pandemic Preparedness	The research of Pandemic Preparedness should lead to innovations, by developing new preventive, diagnostic, and therapeutic counter measures, ensuring the competitiveness of the European Union, joint development and industrial transfers, and the potential creation of innovative companies with high-added-value to create value for the results of this world-class research, on a European level. The SRIA should focus on two main axes. 1) Research and Health and 2) Health & Bio-Tech Research and Innovation.
Innovative Health Initiative Joint Undertaking (IHI JU)	The Innovative Health Initiative will focus on cross-sectoral approaches to facilitate the creation of new products and services to prevent, intercept, diagnose, treat and manage diseases and foster recovery more efficiently. The goal is to lay down foundations for the development of safer and more effective healthcare products or solutions that respond to unmet public health needs and that can be implemented into healthcare systems. This includes optimising the treatment quality, duration and outcome, providing the right intervention to the right patient at the right time.
Transforming Health and Care systems (THCS)	The common vision of THCS is to maintain and improve health in Europe and participating countries by supporting improvement in and transformation of the health and care systems and by thereby delivering high quality, fairly accessible, sustainable, efficient, health promoting resilient health and care systems for all.

Table 2. Relevant European Partnerships within Horizon Europe Cluster 6 (Food, Bioeconomy,Natural Resources, Agriculture and Environment).

Partnership	Goals of the partnership (brief description)
EUP on Animal Health and Welfare (EUP-AH&W)	The European Partnership Animal Health & Welfare (EUP AH&W) will generate key knowledge and develop innovative methodologies, tools and products to promote sustainability in livestock production, both for terrestrial and aquatic animals. It will support the development of an animal friendly livestock sector and reduce the risk of animal infections, both from endemic and emerging origin. The Partnership will also enhance public health and wellbeing by enhancing cross-sector collaboration in a One Health – One Welfare perspective.
Safe and Sustainable Food Systems for People (PSFS)	The overarching vision of the Sustainable Food Systems Partnership is that its actors will collectively achieve environment-friendly, socially secure and fair, economically viable, healthy and safe food systems in Europe.
	R&I Areas: Change the way we eat, the way we process and supply food, the way we connect with food systems and the way we govern food systems.
Accelerating farming systems transition: agroecology living labs and research infrastructures	The partnership aims to accelerate the transition towards sustainable, climate- and ecosystem-friendly farming practices. To do so, it will 1) enable a better comprehension of agroecological processes from farm to landscape levels, 2) boost place-based innovation in co-creative environments and 3) improve the flow and uptake of knowledge and innovations on agroecology.
<u>Water4All – Water</u> <u>security for the</u> <u>planet</u>	Intends to achieve reduced water stress, increased protection of water resources and ecosystems and enhanced resilience, mitigation and adaptation of water systems to global changes. Aims to enable water security for all in the long term through boosting systemic transformations and changes across the entire research – water innovation pipeline, fostering the matchmaking between problem owners and solution providers.

Table 3. Relevant European Initiatives within other EU funding programmes/clusters.

Partnership	Goals of the partnership (brief description)
Joint Action on Antimicrobial Resistance 2 (JAMRAI 2)	JAMRAI 2 aims to: - Support the development and the update of national action plans on AMR - Support the wider uptake of state-of-the-art infection prevention and control ('IPC') - Support antimicrobial stewardship
<u>EIT Health</u>	EIT Health will be delivering solutions to enable European citizens to live longer, healthier lives by promoting innovation.
European Open Science Cloud (EOSC)	The ambition of the European Open Science Cloud (EOSC) is to provide European researchers, innovators, companies and citizens with a federated and open multi-disciplinary environment where they can publish, find and re- use data, tools and services for research, innovation and educational purposes.

Several alignment meetings have already been conducted with the EUP AH&W and a continued close collaboration with them is foreseen to ensure synergies regarding AMR in animal health and welfare and its' impact on human health and to avoid gaps and overlaps. Concrete plans for joint activities and commitments for continuous and practical collaboration will be established once the Roadmap of actions for the two partnerships have been further developed. Initial meetings with the other EU partnerships are planned for the second and third quarters of 2023, to gain more information about their activities and explore synergies. Continuous information exchange, consultations and joint activities are foreseen throughout the duration of the EUP OH AMR. Furthermore, the EUP OH AMR will also be in close contact with WHO, the UN Quadripartite and other international initiatives, such as the Global Leaders Group on Antimicrobial Resistance (AMR Leaders) and the Global AMR R&D Hub, as well as international donors, such as the Wellcome Trust and Bill & Melinda Gates Foundation, to align and seek synergy of agendas and R&I actions. In addition, we will utilise and build on the outcomes of ongoing EU-projects and initiatives, such as One Health EJP and JAMRAI, as well as the national R&I projects in the AMR R&I landscape for uptake and translation of R&I findings.

To further ensure that solutions are readily taken up by the society and that the supported R&I respond to actual needs of the society, the EUP OH AMR will also have continuous contact with the AMR Stakeholder Network, established at the European Public Health Alliance (EPHA) as well as other stakeholders, e.g. associations of farmers and veterinarians. The AMR Stakeholder Network brings together more than 60 leading organisations and individuals, including patient groups, health professional organisations, NGOs for public health, veterinarians etc. at national, regional and European level, covering all dimensions of the OH approach: human health, animal health and environmental factors.

Additional important stakeholders are international organisations, such as, Action on Antibiotic Resistance (ReAct), International Centre for Antimicrobial Resistance Solutions (ICARS) and national initiatives, including those in LMICs and Widening countries, which will facilitate uptake of research results and solutions in different socioeconomic settings. Inclusion of social scientists in the preparatory working groups of the EUP OH AMR, as well as regular interactions with the social science networks, such as The International Network for AMR Social Science (INAMRSS, part of the Global Strategy Lab) and Sonar Global will further help to define and overcome societal barriers of uptake. In order to facilitate translation and uptake of innovative solutions, for e.g., into clinical trials, the EUP OH AMR will also cooperate with international funding initiatives, such as the Combating Antibiotic Resistant Bacteria Biopharmaceutical Accelerator (CARB-X), the Global Antibiotic Research & Development Partnership (GARDP), FIND and the AMR Action fund to advance innovations in the pipeline development. Engagement with industrial associations like BEAM Alliance or EPFIA will also be sought.

The EUP OH AMR will also interact with other relevant stakeholders and policy makers, such as EC directorates (DGs) and EU agencies to align needs and provide scientific evidence-base for policy-making. These include DG for Research and Innovation (DG RTD), DG for Health and Food Safety (DG SANTE, including the EU AMR One Health

Network), DG for Agriculture and Rural Development (DG AGRI), the European Centre for Disease Prevention and Control (ECDC), the European Food Safety Authority (EFSA), the European Medicines Agency (EMA), the European Environment Agency (EEA) and the Health Emergency Preparedness and Response department (HERA).

The stakeholders mentioned here is a non-exclusive list that will expand during the preparation of the EUP OH AMR. During the next phase of the preparation for the EUP OH AMR, meetings with all relevant stakeholders will be organised for information exchange on planned activities. More details of the interactions will be presented in the next version of the SRIA.

Monitoring and Evaluation of the progress of the EUP OH AMR towards its objectives

This section provides a preliminary draft of the framework for the monitoring and evaluation of the EUP OH AMR partnership and the proposed key performance indicators that will support to assess the progress of the partnership towards its goals, objectives and expected impact. The framework will be further developed and the list of the proposed indicators will be revisited and updated as necessary throughout the duration of the project as and when the general, specific and operational objectives (outlined in the intervention logic) will be updated and the roadmap of actions will be finalised.

The basis for the development of the common framework for monitoring and evaluation of the EUP OH AMR is to assess progress of the partnership to achieve the general, specific and operational objectives outlined in the intervention logic (p 12-18) and monitor the expected outcomes and impact of the EUP OH AMR. The framework is two-fold and includes:

- monitoring of the performance of the Partnership towards meeting its objectives (objectives of the Partnership -> activities of the Partnership -> outcomes and impact of the Partnership)
- monitoring of the performance of the research projects funded through the Partnership (objectives of the funded research project -> activities of the funded research project -> outputs, outcomes and impact of the funded research project)

The framework is being developed in alignment with the common life-cycle criteria put forward by Horizon Europe to monitor European Partnerships as well as EUP OH AMR specific indicators are being developed (Table 4) that will support monitoring of the progress of the EUP OH AMR and also contribution of the EUP OH AMR in achieving the various objectives. These KPIs will evolve together with the development of the intervention logic. The suggested KPIs will, thus, be revisited and updated even during the lifetime of the EUP OH AMR according to the needs and suggestions of the various governing bodies and advisory committees of the Partnership.

The proposed KPIs include output indicators at the operational level that can be interpreted after a short term, as well as mid-term and long-term indicators for assessing outcomes and to demonstrate added-value, benefits and impacts for science and society. The latter will require longer time and might not be attained until after the end of the programme. Data collection and reporting on the KPIs of the EUP OH AMR will be conducted through internal surveys and also streamlined according to the reporting requirements of the European Commission on the common indicators developed for all the partnerships in the Horizon Europe framework programme.

 Table 4. Proposed indicators to monitor the performance of the OH AMR Partnership.

Key performance Indicators (KPIs)	Examples of units of measurement of the KPIs		
Expected impact			
Strengthened global cross- sectoral and cross-border One Health (OH) AMR research and innovation (R&I) ecosystem	 Strengthened cooperation of the ERA to support R&I to combat AMR Strengthened capacity (talent, knowledge, data, tools, resources) and integration of a OH cross-sectoral and transdisciplinary AMR R&I ecosystem Improved dialogue and knowledge exchange between researchers, industry, healthcare, policymakers and end-users 		
Knowledge, evidence-based measures and innovative solutions put into action	 Application of knowledge generated through cross-border, intersectoral and interdisciplinary R&I resulting in improved policies and understanding of AMR not only as a biological issue but as a social issue Number of policy documents (guidelines, recommendations, strategic roadmaps) in which funded OH AMR R&I project results are cited Innovative solutions fulfilling unmet medical needs of human patients and animals, reducing the impact of AMR on food security and environment and contributing to the wellbeing of the society and EU meeting policy priorities and SDG objectives 		
Expected outcome			
Alignment of R&I priorities and synergistic activities	 Alignment with R&I priorities/ objectives of the research action plan at the EU level and with other international initiatives (e.g. WHO) New trans-sectoral and trans-disciplinary collaborations established by the EUP OH AMR (within and beyond Europe) Synergies established by EUP OH AMR with widening countries and LMICs (country specific research management bodies/ AMR programmes) to enable an environment for co-creating/ exchanges in R&I in different resource settings. 		
Data sharing and (re)utilisation of resources	 Number and type of R&I project outcomes (data, technical tools, protocols and guidelines) and resources generated and made available as FAIR in open platforms Number of projects funded utilising both new and existing data/research resources or platforms/infrastructure Number of projects providing data in recognised repositories Number of projects funded developing links between data/research resources or platforms/infrastructure across sectors and disciplines 		
Knowledge translation for innovations and implementation	 Engagement of projects with industry, regulators, policymakers, social science sectors, patient and other end-user organisations for innovation and translation of research results Share of projects with R&I outcomes adopted for implementation of solutions/products and/or as base for creation of (start-up) companies Number of products/developments transitioning to the market or are at advanced TRL maturity in pipeline development 		

Key performance Indicators (KPIs)	Examples of units of measurement of the KPIs		
	- Number and types of R&I outputs that are disseminated in a format accessible for end users and citizens at large (e.g. videos, infographics, summaries, social media campaigns)		
R&I based knowledge generation and development of systems-wide solutions	 Number of antimicrobial targets and candidates, therapeutic alternatives, new and improved diagnostics developed Number of innovative products, processes or methods resulted (including IPR applications); creation of start-ups/companies as drivers of innovation Scientific basis for the development of possible future regulatory framework/legislation proposals/policy Number of evidence-based treatment regimens, stewardship and prevention programmes developed Number of original research articles, guidelines, recommendations, strategy roadmaps published (with open access status) 		
Expected output			
Global stakeholder engagement	 Establishment of platform among countries (policymaker, regulator), funders/donors, sectoral researchers and industry stakeholders within and outside Europe Membership growth (number and diversity of funding organisations) Joint investment committed for OH AMR R&I actions Diversity of engaged stakeholders (e.g. public, private, geographical and sectoral diversity) Participation of Widening countries and LMICs 		
Joint synergistic activities	 Number and type of activities with other HE partnerships Number and type of activities and social science and science partnerships facilitated within and around Europe Number of partnerships established between Europe-LMIC country research management bodies/ AMR programs for establishing an environment for co-creating/ exchanges in R&I or pilot in different resource settings Number of other global collaborations on transversal activities to promote collective mutual learning and exchange of knowledge and solutions between sectors Continued development of the joint SRIA and roadmap of actions 		
Upskilled researchers and increased research capacity	 Share of research and innovation partners in funded projects representing different types of organisations (academic, industry, public health, civil society etc.) Number of Early Career Researchers funded in research projects as well as undertaking mobility programmes, mentoring, training, and benefitting from capacity and career building programmes Number of researchers funded from Widening countries Number of researchers funded from LMICs Knowledge transfer activities targeted to LMICs and widening countries Number and type of activities facilitating and/or supporting sharing and (re)use of AMR data/research resources 		

Key performance Indicators (KPIs)	Examples of units of measurement of the KPIs
Joint activities and actions addressing prioritised OH AMR R&I objectives	 Types and share of R&I activities (e.g. joint transnational calls and other activities) in SRIA thematic areas (Therapeutics, Diagnostics, Surveillance, Transmission and Evolution, Interventions for prevention and mitigation of AMR) Share of projects integrating cross-cutting issues including socio-economic and global aspects with OH perspective Number of transnational projects and networks funded Number of projects which includes industry/SME with increased TRL maturity Number and share of projects where citizens and end-users contribute to the co-creation of R&I content Number and type of activities for testing, validation and development of innovation and translation of research results (e.g., through specific implementation research/stewardship/intervention trial calls and other activities)
Community engagement and knowledge dissemination to end-users	 Number of activities on science - policy interface, science communication, citizen science etc involving researchers and endusers. Number and type of early engagement and dissemination activities between researchers, industry, policymakers, regulators and other end-user organisations Number and type of stakeholders engaged in early engagement and dissemination activities (industry, regulators, policymakers, civil society) and other end-users

The EUP OH AMR is also expected to support a diverse portfolio of research projects and networks to generate new knowledge on the R&I objectives to be identified and prioritised from the Strategic Research and Innovation Agenda of the partnership. Therefore, monitoring and evaluation of the outputs and outcomes of the funded research projects and networks is necessary to assess their contribution in improved scientific understanding, developing innovations and creating impact on the society in decreasing the burden on AMR. Indicators will be also developed in line with similar actions resulting in several research outputs and outcomes. More details to each of the stages of monitoring and evaluation of the supported research projects under the EUP OH AMR will also be included in the common monitoring and evaluation framework document that is under development and expected to be published next year.

Development of the SRIA and plan for its' update

The current version of the SRIA should be considered as a preliminary draft and will be subjected to several consultations before it is adopted by the partners of the EUP OH AMR in 2025.

The draft SRIA has been developed by the CSA DESIGN OH AMR, in collaboration with the JPIAMR member states and funding organisations that have expressed interest in joining the EUP OH AMR, the JPIAMR Scientific Advisory Board (SAB) and additional experts. In particular, the SAB and additional experts have worked extensively on the R&I objectives in thematic drafting groups. A full acknowledgement list is provided in the long version of the Research and Innovation Objectives of the EUP OH AMR.

The different parts of the SRIA have been subjected to a number of consultations with the research community and relevant stakeholders to identify gaps and needs. A full list of the consultations that were conducted for the R&I objectives is found in the <u>long</u> version of the Research and Innovation Objectives.

The next step in the SRIA development will be to further define and prioritise the activities (calls for funding and transversal activities) of the EUP OH AMR. The prioritisation will be based on challenges, gaps and unmet needs, and efforts will be put on breaking silos between the thematic areas, and on integrating a One Health, interdisciplinary and innovation perspective. A draft Roadmap of Actions is expected to be developed by the end of 2023.

The next version of the draft SRIA will be prepared by April 2024 and will include a more developed intervention logic, framework for monitoring and evaluation, further defined activities and funding instruments and more concrete plans for interactions with other partnerships, initiatives and stakeholders. In addition, the SRIA, including the R&I objectives, will be further aligned with the UN Quadripartite "A One Health Priority Research Agenda for Antimicrobial Resistance" and the "WHO Global AMR research agenda in the human health sector", which are currently under development.



The process and timeline of the previous and future development of the SRIA and related documents are shown Figure 6.

Figure 6. Timeline of the development of the SRIA.

Abbreviations

AMC	Antimicrobial consumption
AMR	Antimicrobial Resistance
AMU	Antimicrobial Use
CSA	Coordination and Support Action
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
EEA	European Environment Agency
EFSA	European Food Safety Authority
EMA	European Medicines Agency
ERA4Health	ERA for Health Research
EU	European Union
EUP AH&W	European Partnership on Animal Health and Welfare
EUP OH AMR	European Partnership on One Health Antimicrobial Resistance
FAIR	Findable, Accessible, Interoperable and Reusable
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross domestic product
GH EDCTP3 JU	Global Health European & Developing Countries Clinical Trials Partnership Joint Undertaking
GO	General objective
HERA	Health Emergency Preparedness and Response Department
JAMRAI	Joint Action on Antimicrobial Resistance
JPIAMR	Joint Programming Initiative on AMR
JTC	Joint transnational call
КРІ	Key Performance Indicators
LMIC	Low- and middle-income country
NGO	Non-governmental organisations
ОН	One Health
OH AMR	One Health AMR
One Health EJP	One Health European Joint Programming
00	Operational objective
PK/PD	Pharmacokinetic/pharmacodynamic
R&I	Research and innovation
SDG	Sustainable Development Goal
SME	Small and medium-sized enterprise
SRIA	Strategic Research and Innovation Agenda
SO	Specific objective
UN	United Nations

UNEP	UN Environment Programme
WHO	World Health Organization
WOAH	World Organisation for Animal Health