Dynamic Dashboard - Categories and Definitions

The definitions are intended to be applicable across the different One Health sectors. They are updated appropriately when investments/projects addressing other One Health areas are included in the Dynamic Dashboard.

R&D in scope	Basic and applied research on AMR that covers all One Health sectors (human, animal, plant and environment). The infectious agents in scope are provided here. The activities could include but are not limited to: • All types of product-oriented and product-based R&D, including research, discovery, development (including field trials), first registration and post registration studies for therapeutics, preventives, promotants and diagnostics • Basic research that improves understanding of the pathogen, virulence, transmission, impact of external factors and roles and interaction of different One Health sectors and is not necessarily geared towards a specific product, policies or operational processes • Operational/implementation research such as exploring improvements to surveillance, access to and optimal use of products, epidemiology-related studies, digital products, infection prevention and control and disease management programs • Research of new or existing medical interventions • Research into quality and fake or sub-standard products • Research to inform policy or regulation development or revision • Relevant research training (such as support for PhDs & post-docs) and network establishment (capacity building) • Research on breeding genetic variances targeting AMR • Research that leads to reduced antibiotic/antimicrobial use (agent not specified)

Exclusion criteria	Information will not be collected for projects or investments on: • Research on microbiome and the use of viral vectors in the context of non-communicable diseases, such as obesity, autoimmune diseases, cancer, allergies • R&D on virally caused cancers, reactivated viral infections in immunocompromised individuals such cytomegalovirus or progressive multifocal leukoencephalopathy • Grants solely for symposia or meetings or travel • Funding for buildings / capital investments • Training and professorships where there is not a strong focus on AMR R&D, or • Research into insect vector control

Research Area

Basic research	Research that addresses fundamental aspects of a concept or phenomenon and aims at increasing scientific knowledge, understanding about the disease, immune response, processes or pathogen but is not yet directed towards a specific product, policies, or operational processes and corresponds to Technology Readiness Levels (TRL, see Annex for definition) 1-3. This is sub-categorised into either 'fundamental' or 'towards a product' and could include but is not limited to: <u>Fundamental - no clear path to product development (TLR 1-2)</u> • Research into the development and mechanisms of persistence, transmission, virulence, immunology, biology and pathology; genetics (including genetically resistant animals and plants); role of the microbiome in maintenance of health; role of antibiotics in growth promotion; epidemiology and burden; and the interaction between One Health sectors • Fundamental understanding of biological processes or chemistry involved in the synthesis of compounds, including adjuvants and antigens <u>Towards a Product - has the potential to become a product (TLR 3)</u> • Search for a potential therapeutic, preventive, promotant or diagnostic target • Early research for the development of imaging or detection technologies/assays • Development of technologies and *in silico/in vitro/in vivo* models that assist with the design and testing of e.g. drugs and vaccines such as tissue culture and animal models (e.g. mouse models for sepsis, challenge models) • Identification of mode of action of putative new products targeting the pathogen, host and/or the microbiome

	• "Platform technologies" e.g. for vaccines that broadly refer to a system that uses the same basic components as a backbone, but can be adapted for use against different pathogens by inserting new sequences (which then would become product-specific)
Therapeutics	Any product-specific R&D designed for the treatment of infection with an antimicrobial across all product-specific R&D stages such as screening of compounds/antigens, early stages of optimising a hit or work to better understand a target to post registration studies. This could include but is not limited to: • Improvement of current antimicrobials, treatment regiments and therapies • Investigation of combination therapies • Dose optimisation studies • Investigation of old or off market antimicrobials for optimisation or new targets • Development of new antimicrobials and therapeutic alternatives to 'traditional' antimicrobials, including but not limited to small molecules, natural products, antibodies, vaccines, probiotics and faecal transplant therapy, bacteriophages, antimicrobial peptides, lysins, antitoxins and immune modulators • Drug quality (including fake or sub-standard drugs) and properties such as oral bioavailability, long half-life, etc that are secondary to activity but can be essential to market viability • Characterise a target for which some evidence of its usefulness is already available • Combining identification of target and other aspects such as screening/optimising of compounds
Preventives	Any product-specific R&D designed to prevent systemic disease (no symptoms, could be both sick and healthy subjects). This is sub-categorised into either 'Vaccines' or 'Other' and could include but is not limited to: <u>Preventives – Vaccines:</u> Defined as a product (usually a biological preparation or substance) that stimulates the adaptive immune system to develop long-lasting protective immunity against antigens from pathogens and is administered primarily to prevent disease. This is achieved through the generation of antigen-specific memory T and B cells (adaptive/acquired immune system). • Research that addresses challenges in developing vaccines, e.g. identification of protective antigens, defining correlates of protection, understanding most effective antigen delivery methods and stimulating long-term protective immune responses • Identification of vaccine candidate(s): Screening of potential natural or synthetic antigens and other vaccine components (e.g. adjuvants) in a pathogen/disease-specific context and may include e.g. protein/peptide/epitope libraries, antigen-expressing vectors, substances derived from pathogens, weakened pathogens or their toxins, serological activity (neutralising and non-neutralising) • Studies conducted to assess vaccine candidate for safety and efficacy (e.g. in tissue-culture or cell-culture and animal testing and clinical trials) <u>Preventives – Other:</u> Defined as a product (often a drug) that prevents disease through other means than vaccination and by itself does not generate an antigen-specific memory immune response. • Prophylactics – medication/treatment to prevent disease from occurring- e.g. administration of antimicrobial with appropriate therapeutic dose for limited and disease appropriate duration in healthy subjects at risk of specific infection or where infection/disease is likely to occur • Immune modulators – activate, boost or restore normal immune function independent on the pathogen causing infection (not antigen-specific); These include cytokines, lipopolysaccharides, short segments of bacterial DNA that also stimulate innate immune responses (i.e., CpGs), antibodies, and certain plant materials • Trait-selective breeding of animals/plants resistant to AMR infections, e.g. genome editing technologies for the generation of genome editing animals • Other disease prevention products, such as biofilm inhibitor (inhibition of surface adhesion, interference with quorum-sensing system, disruption)
Diagnostics ***includes detection, screening and diagnostics***	Any product-specific R&D aimed at the development or improvement of detection, screening or diagnosis. This could include but is not limited to: • Identification of causative agent (including distinguishing between viral and bacterial) and identification of resistance (including resistance profiles), including susceptibility testing • Development of diagnostic or prognostic tests and devices for clinical use, and use in the field (e.g. animal farm-settings)

	• Tests and screening tools for population-based, epidemiological studies and surveillance routines aiming at the identification of determinants that are involved in the cause, risk or development of AMR • Development of companion diagnostics – provide information for the safe and effective use of a corresponding drug or biological product • Development of tests or detection tools including machine learning predictions to identify infected individuals or status of infections with AMR-relevant agent(s) within a herd/flock) • Diagnostic tools in support of trait-selective breeding of animals/plants, e.g. genotyping technologies to improve disease resistance (e.g. SNPs)
Promotants	Any product-specific R&D designed to improve or maintain health/welfare and increase productivity and/or growth in the absence of disease/infection. They are usually provided as food/feed additives. This could include but is not limited to: • Non-medically important antimicrobials at sub- or non-therapeutic doses used for an on-going duration • Probiotics - live cultures of microorganisms (e.g., yeast, algae, fungi and bacteria) added to the diet to improve the balance of microbial communities in the gastrointestinal tract • Prebiotics - organic compounds such as certain sugars that, when added to the diet, are indigestible but are broken down by certain beneficial microorganisms in the gut, which selectively stimulates these and other microorganisms' growth • Antimicrobial peptides - short molecules with antibacterial properties that are toxic to certain bacteria • Phytochemicals - plant-derived compounds, such as essential oils or tannins that may have antibacterial and growth promoting effects • Organic acids, enzymes and other alternatives, such as heavy metals (zinc, copper) and clay minerals
Other products	Any product-specific R&D that does not fit under therapeutics, preventives, promotants or diagnostics. It does not include devices that are part of delivery systems for therapeutics, vaccines or diagnostics. This could include but is not limited to: • **Biocides:** used as antiseptics and disinfectants – chemicals and biological agents used for the expressed purpose to control, deter, inhibit or kill harmful microorganisms • **Biofilm**-related products (material, devices, particles, etc) that prevent, prohibit or interfere with biofilms • **Other products** like medical devices, wound healing products/dressing, anti-adhesions • Technologies to improve and monitor health, production and welfare in animals such as sensors/devices (via microbiome/weight gain, etc) at individual and herd/flock level (reduction of AMU)
Operational ***includes operational and implementation***	Operational and implementation research that aids in decision making and management strategies and could include but is not limited to: • **Infection prevention and control** (IPC): Management and interventions aimed at optimizing clinical, veterinary or farming practice related to: disinfection, sterilisation and disease management programmes (e.g. biosecurity, husbandry methods, use of vaccination, health management) and evidence-based guidelines/policies of IPC programmes • **Optimal use / Stewardship**: Research and studies to optimise the uptake and use of products (antimicrobials, diagnostics and vaccines and other technologies) with the aim of reducing the emergence or rate of development of resistance and/or the need to consume antibiotics, and normally does not impact product-specific label (see registration and implementation). Includes trials which compare agents against each other to inform clinical practice and guideline development • **Access and Availability**: Work that aims to improve the access and availability of AMR- and infection-reducing technologies • **Surveillance**: population-level analysis of disease surveillance or monitoring, antimicrobial consumption/usage and resistance trends/development/susceptibility; includes specific informatics tool for collection, management and analysis of AMR testing data • **Epidemiology:** Studies that analyse determinants of health and disease conditions in defined populations, specifically how, who, when, and where they occur. Major study areas include disease causation, transmission, outbreak investigation, disease surveillance, environmental epidemiology, occupational epidemiology, screening, biomonitoring, and comparisons of treatment effects such as in clinical trials

	• **Social Science:** Research to inform behavioural change among humans (individuals, groups such as farmers, organisations/companies,) or in relation to animals, economic analysis to inform and quantify challenges or costs-solutions. Impacts of external factors (such as assessments of the contribution of pollution or contamination); the environmental impact of new antimicrobials; digital products
Capacity building ***includes capacity building and infrastructure***	Efforts aiming to improve the human or infrastructural resource capacity to address the challenges of AMR. May include but is not be limited to: laboratory capacity, staff training, network formation (for knowledge sharing only), infrastructural or process improvements for example clinical trial conduct – that goes beyond a single product.
Policy	Research or investments that will inform the development of, review or revision of policies and regulations (national and international). This could include but is not limited to: • Relevant research, not listed above, with an objective of informing or proposing concrete changes to policy of influencing stakeholder-action in the field of AMR • Impact of care services such as research into how social factors, financing systems, structures and processes, technologies and behaviours affect access to care, the effectiveness of care, and development and evaluation of interventions to improve services • Economic impact, cost benefit analysis, economic models and incentives and market analysis • Health technology assessments • Supporting evidence of intervention into national health programmes (economic impact)

Product-specific Definitions

Discovery	The discovery and preclinical testing of innovative methods, processes, active ingredients, antigens, adjuvants, delivery vehicles/methods, diagnostics and corresponds to 'Technology Readiness Levels' 4-5. Several in vitro and in vivo methods are applied in order to assess biological activity, immunogenicity, efficacy and safety (toxicological studies) of potential candidates. The preclinical phase concludes with submission of an IND (Investigational New Drug) application with FDA-US or CTA (Clinical Trial Application) EMA-EU by submitting the IMPD (Investigational Medicinal Product Dossier). • For therapeutics and drug preventives this includes target validation, the hit discovery process (hit identification, hit to lead, lead identification and optimisation) • For preventative biologics such as vaccines this includes identification, selection and improvement/characterisation of vaccine components (antigen, adjuvant, carrier/delivery system, etc) that have the ability to induce immunogenicity (induction of cellular and humoral immune response/adaptive immune responses). This may include testing of serum in order to identify antigens/immunogens (samples from exposed individuals for testing immunogenicity), testing for ability to induce protective immune responses (e.g. by challenge with pathogen in animal or human models) • For diagnostics, this includes concept, feasibility, prototype development, and development of technical specifications • In Animal Health, includes market assessment to identify unmet animal health needs, preclinical/feasibility studies, including proof-of-concept safety and efficacy studies, and are usually conducted in target species
Development	The progression of selected candidates from discovery to commercialisation including investigating the efficacy and safety of the product in the field (e.g. clinical trials under GCP conditions), reformulation and repurposing and validation of manufacturing processes. This stage concludes with submission of an NDA (New Drug Application) or NADA (New Animal Drug Application) with the FDA/CVM or appropriate applications/dossiers with agencies in other countries and corresponds to 'Technology Readiness Levels' 6-8. • In Human Health, for therapeutics and preventives this includes clinical trial Phase 1 to Phase 3, and trials that will lead to an expansion of the product label (additional indications) • In Animal Health, Target Animal Safety Studies (TASS) and Target Animal Effectiveness Studies (TAES) are conducted and include dose-finding and field trials (designed to mimic its 'everyday' use) • For diagnostics this includes design lock, validation of manufacturing process, validation of accuracy and analytical performance in (clinical) trials, validation of performance and operational characteristics during uncontrolled routine use in programmatic settings

Approval and post-approval	Refers to the phase following first market authorisation (early-commercialisation) for a specific product and corresponds to 'Technology Readiness Levels' 9. This could include but is not limited to: • Filing in other, subsequent, legal jurisdictions (countries) • All subsequent research and monitoring that is a requirement by regulators (post-approval requirements or post-authorisation obligations), such as: paediatric investigation plans (PIPs), pharmacovigilance (phase 4) etc • Research into product optimisation (such as bioavailability, formulations) • Clinical studies which help inform how a product should be used in a clinical setting to inform among others product formulary inclusion, guideline incorporation, value-assessment and payor decisions

Funders/Investors

In general, **public funding** is sponsored by a government agency or other publicly-recognized organization, whereas **private funds** are donated mainly through private corporations or philanthropic efforts by a private organization or individual or are invested directly by the private legal entity.

Public – government	Public funding provided at any level of government. This also includes agencies if located within a ministry/department portfolio.
Public – other	• **Research councils:** separate legal entities and politically independent from government (they may still be answerable) • **Public universities:** state or government owned or receive significant public funds through government
Private – for profit	• **Pharmaceutical and Biotechnology companies, other relevant entities:** entities that research, develop, manufacture, market, distribute, import, offers for sale or sell pharmaceutical products or other products relevant to AMR. • **Small and medium-sized enterprises (SME):** non-subsidiary, independent firms with fewer than 250 employees and with annual turnover under EUR 50 million / US $ 55 million.
Private – not for profit	**Foundations:** independent legal entities set up for charitable purpose and are funded by an endowment, an individual, a family or business (corporation). They are often controlled by an independent Board.
Multilateral organisations	Refers to an alliance of multiple countries pursuing a common goal and deal with issues that are global priorities. Examples include the UN organisations such as WHO, FAO and UNEP and others such as OIE, World Bank, G20, EIB and GAVI.
Funding distributor	In the AMR field funders support organisations that in turn fund external projects or invest in own activities. Both the upstream grants and the downstream investments will be captured. To avoid double-counting, the notion of funding distributor has been introduced in the data-base. Projects/investments made by a funding distributor are referenced to said funding distributor. This then also allows to trace back the funding flow to where the original investment came from. Examples of such funding distributors are CARB-X and GARDP. The former is a funding organisation, the latter a product-development-partnership investing mostly in its own projects. Funding arrangements, where different funders work together through a "virtual pool of funding" are not considered a funding distributor, as the individual funded projects are each recorded only once from the respective funders.

Type of Research Organisations

A research organisation is an entity, irrespective of its legal status (organised under public or private law) or way of financing, whose primary goal is to independently conduct fundamental or applied research (industrial research and experimental development).

Industry **SME**	Refers to a business entity with the aim of gaining profit. Belonging to industry but defined and recorded separately are 'small and medium-sized enterprises (SME)': non-subsidiary, independent firms with fewer than 250 employees and with annual turnover under EUR 50 million / US $ 55 million
Private research institution/facility	Refers to a privately owned building or facility whose primary mission is to pursue research in a specific area and which is not a university. Examples include, Scripps Research, Broad Institute, Salk Institute, J. Craig Venter Institute, La Jolla Institute for Immunology, and Cold Spring Harbor Laboratory.

Public bodies	Refers to an organisation operated mainly by the government of one or multiple countries/territories, which is not a university or a public research institution/facility and includes international organisations. Examples include, Ministry, City, City Council, World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO) and World Organisation for Animal Health (OIE).
Public research institution/facility	Refers to a publicly owned building or facility whose primary mission is to pursue research in a specific area and which is not a university. Examples include, National Center for Global Health and Medicine, Max Planck Society (MPG).
University	Refers to a public or private educational institution where research takes place. Can grant degrees and includes faculties, departments and schools.
Other	Used in cases where none of the previously mentioned types are suitable, such as non-profit organisation (NGO) and Civil Society Organisations. Examples include, The Global Fund to Fight AIDS, Tuberculosis and Malaria, GAVI, Doctors Without Borders.

Diseases and Syndromes

Includes diseases and syndromes that affect humans and animal species.

Disease or syndromes	Bloodstream infections: • The presence of viable bacteria or fungi in the bloodstream, demonstrated by positive blood culture(s). Bone and joint infections: • Any infection of the bone or joints noting there may be some cross over with skin and soft tissue infection. Gastrointestinal tract infections: • Any infection (or intoxication or inflammation caused by an infectious agent) of the gastrointestinal including the oesophagus, stomach, small and large intestine and rectum and the accessory organs of digestion, the liver, gallbladder and pancreas. Infections in pregnancy, during childbirth or in the puerperium period: • Includes both maternal and obstetric infections and infections during the first six weeks following birth. Nervous and sensory system infections: • Any infection of the nervous system (central and/or peripheral) or sensory organs such as ears, eyes and tongue. It excludes the skin (which is captured under skin and soft tissue infections) and the nose (which is captured under respiratory tract infection). Respiratory tract infections: • Any infection of the upper or lower respiratory tract including the nasal cavity, pharynx, larynx, trachea, and lungs. Sepsis (incl. Host response to infection): • An inflammatory immune response triggered by an infection and where host response to infection causes injury to tissues and organs. Sexually transmissible infections: • Infections that are passed from one person to another through sexual contact. Noting that there may be cross over with other areas including UTIs, skin and soft tissue infection, infections in pregnancy, during childbirth or in the puerperium period, and gastrointestinal tract infections. Skin and soft tissue infections: • An infection of the layers of the skin and underlying soft tissues including subcutaneous tissue, muscles, tendons, ligaments, fascia, and fibrous tissue. Urinary tract infections: • An infection in any part of the urinary system including kidneys, ureters, bladder and urethra. Lameness: • Can be caused by a group of infections (most common bacterial) specific to the feet and involves damage to the skin and epidermis due to injury or prolonged moisture. Mastitis: • Persistent, inflammatory reaction of the mammary gland and tissue (breast or udder) due to microorganism infection (most common bacterial).

Sub-Categories for Sector – Animal

The definitions below include any animal and animal-derived components such as milk, meat, eggs, fur, leather and wool. Within each animal group all ages and gender are include. Animal-derived products for human consumption (food) follow the same categorization and are tagged as 'Food' accordingly (visualization in the Dynamic Dashboard coming soon). Farmed animal groups include livestock, poultry, aquaculture and insects and non-farmed animal groups include companion animals and wildlife.

Animal		no information regarding the animal group, name or species provided
Farmed-not specified		refers to domesticated or farmed animals and without further information regarding the animal group, name or species
Livestock		refers to any breed or population of animals kept by humans for a useful, commercial purpose and includes animals raised in an agriculture setting to produce labor and commodities such as meat, milk, fur, leather and wool
	Cattle	refers to any cattle (dairy, beef and meat), including cows, bulls, oxen or calves
	Small ruminants	refers to sheep (Ovis spp) and goats (Capra spp)
	Pig	refers to domesticated pigs (genus Sus), including terms e.g. swine, porcine, hogs, pork
	Livestock-Other Food	includes all other domesticated, farmed or captive wild animals (terrestrial) such as bovine (buffalo, bison, yak), camelidae (camels, llamas, alpacas), equidae (horses, donkey, mules/hinnies), lagomorphs (hares and rabbits), cervids
	Livestock-Other Non-Food	refers to all domesticated, farmed or captive wild animals (terrestrial) kept for fur and skin
	Not specified	refers to term 'livestock' without additional information regarding the animal group, name or species
Poultry		Domesticated or farmed birds, including backyard poultry, kept by humans for their eggs, meat or feathers
	Chicken	refers to chicken (Gallus domesticus), including hen, rooster/cock, chicks and terms such as broiler
	Other	includes e.g. turkey, quail, ostrich, pigeons, ducks, geese
	Not specified	refers to term 'poultry' without additional information regarding the animal group, name or species
Aquaculture		refers to farming of aquatic animals and implies some form of intervention in the rearing process to enhance production (e.g. feeding, regular stocking, protection from predators).
	Fish	refers to any fresh or saltwater species, most common farmed fish are in order carp, salmon, tilapia and catfish
	Other	includes species within e.g. crustaceans, mollusca and amphibia and terms such as shellfish
	Not specified	refers to term 'aquaculture' without additional information regarding the animal group, name or species
Insects		refers to small hexapod invertebrates within the arthropod phylum
	Bees	refers to domesticated honeybees (genus Apis)
	Other	includes e.g. silkworm
	Not specified	refers to term 'insects' without additional information regarding the animal group, name or species
Companion Animals		refers to animals kept as pets, but can also be in a laboratory and medical/educational set-up
	Mammals	includes e.g. cats, dogs, ferrets, rodents
	Other	can includes e.g. birds, reptiles (except if captured above)
	Not specified	refers to term 'companion animal' without additional information regarding the animal group, name or species
Wildlife		refers to any feral animal, captive wild animal or wild animal (non-domesticated and non-farmed) that has a phenotype unaffected by human selection and lives independent of direct human supervision or control (exception zoo animals)

ANNEX

Technology readiness level (TRL)

TRL 1 – basic principles observed
TRL 2 – technology concept formulated
TRL 3 – experimental proof of concept
TRL 4 – technology validated in lab
TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 7 – system prototype demonstration in operational environment
TRL 8 – system complete and qualified
TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)