



Module G09

Generic Foundational Course

Introduction to Antimicrobial Resistance (AMR)

NGS Academy for the Africa CDC

Module G09

Introduction to Antimicrobial Resistance (AMR)

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Module last updated:
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Number of sessions	3–4
Total learning time	1–1.5 days
Target audience	All personas - wet laboratory personnel (i.e., scientists, laboratory technicians, etc.), dry laboratory personnel (epidemiologists, bioinformatics scientists, and bioinformaticians), and managerial personnel (i.e., HODs, laboratory managers, policymakers, etc.).
Format	Lectures, videos
Level of the module	Introductory



Contributors

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Recommended prerequisite module(s)

[Module G01. An Introduction to Basic Molecular and Microbial Biology](#)




Module description

This module provides an introduction to antimicrobial resistance (AMR) and how it develops, some of the epidemiology of AMR, and the national surveillance programmes in Africa around AMR. Antimicrobial resistance poses a threat to the safety and quality of agricultural food sources and products as well as animal and human health. Therefore, the surveillance of AMR is an essential public health service that serves to guide global response, inform policy, and aid communication. In this module, participants are introduced to the following topics and/or concepts:

An Overview of Antimicrobial Resistance

- The definition of AMR and how it is caused
- Mutation frequencies and antimicrobial resistance
- General AMR principles

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- The role of excessive and improper antimicrobial utilisation, in healthcare and agriculture, in mediating AMR
 - The WHO and Africa CDC's priority list of causative pathogens
 - The socioeconomic and environmental factors that propagate AMR
 - The role of diagnostics in reducing the prevalence of AMR as well as guiding the appropriate use of antimicrobials and improving patient care
 - Different types of vaccines
 - The implications of vaccine escape on the vaccine biotechnology process
 - The advantages and disadvantages of different types of vaccines regarding the concept of vaccine escape
 - Different challenges in vaccine development around AMR
 - Using next-generation antimicrobials to target the mechanisms of infection
 - The concept of antibiotic cycling and resistance evolution
 - The utilisation of existing AMR-related databases and resources (including CARD, NCBI, and PATRIC)
 - The theory and use of bioinformatics tools to detect AMR genes from genomes (e.g., AMRFinderPlus)
 - How to compare and systematically report results from AMR genomics using hAMRonization
 - A practical introduction to bioinformatics workflows for AMR genomics

Antimicrobial Resistance Surveillance, Monitoring, Evaluation, and Response

- An introduction to genomic surveillance of AMR
- The significance of surveillance in AMR and effective responses to AMR
- Local AMR epidemiology – investigating transmission of clones and AMR
- The various role players and their roles in AMR surveillance and response
- Analysis of resistance in genomes
- Antimicrobial stewardship
- Rapid syndromic testing tools and techniques for antimicrobial use
- The impact of syndromic testing on existing antimicrobial stewardship programs
- The opportunities in and challenges of using syndromic testing as a rapid treatment response
- The role of surveillance in identifying emerging infectious diseases and pre-emptive vaccine development to prevent future pandemics
- Integrated surveillance of AMR and AMU: A one health approach
- The successes and challenges of vaccine use in outbreaks and pandemics
- Strategies to address AMR and prevent future pandemics

Ethics of AMR Surveillance, Monitoring, and Evaluation

- The ethical significance of antimicrobial resistance
- Ethical approaches to the control of AMR
- The ethics of antibiotic resistance
- The ethical perspective of antibiotic restrictions
- Ethical tensions around mitigating AMR in low- to middle-income countries



Module learning outcomes

On completion of this module, the participants will have a basic understanding of, or will be able to:

An Overview of Antimicrobial Resistance

- Explain the concept and aetiology of microbial drug resistance
- Discuss the socioeconomic and environmental factors that propagate AMR
- Describe the role of diagnostics in reducing the prevalence of AMR
- Discuss the role of vaccines in combating antimicrobial resistance
- Explain the process of vaccine development, manufacturing, and safety testing
- List the advantages and disadvantages of different types of vaccines
- Explain the challenges of vaccine development around AMR
- Discuss how antibiotic cycling affects resistance evolution independently of collateral sensitivity
- Apply existing AMR-related databases and resources
- Discuss the theory and use of bioinformatics tools to detect AMR genes from genomes
- Compare and systematically report results from AMR genomics using hAMRonization
- Describe bioinformatics workflows for AMR genomics
- Discuss the significance of AMR surveillance and public health responses
- Explain how vaccine safety, efficacy, and effectiveness are determined

Antimicrobial Resistance Surveillance, Monitoring, Evaluation, and Response

- Discuss the significance of genomic surveillance of AMR and the effective responses to AMR
- Identify the various role players, and their roles, in AMR surveillance and response
- Discuss the concept of antimicrobial stewardship
- List rapid syndromic testing tools and techniques for antimicrobial use
- Discuss the impact of syndromic testing on existing antimicrobial stewardship programs
- Discuss the opportunities and challenges of using syndromic testing as a rapid treatment response
- Explain the successes and challenges of vaccine use in outbreaks and pandemics
- Discuss the role of mitigating AMR in preventing future pandemics
- Explain the role of surveillance in identifying emerging infectious diseases and pre-emptive vaccine development to prevent future pandemics
- Discuss integrated surveillance of AMR and AMU: A one health approach

Ethics of AMR Surveillance, Monitoring, and Evaluation

- Discuss the ethics around AMR and the ethical approaches taken to control it
- Describe the ethics involved in antibiotic resistance
- Discuss antibiotic restrictions from an ethical perspective
- Explain some of the ethical tensions around mitigating AMR in low- to middle-income countries



Module assessments

Module practical: Not applicable

Module quiz: Assessment questions available on the [ASLM platform](#)



Module resources

- [UNEP | What is antimicrobial resistance and why is it a growing threat?](#)
- [WHO Resources | Antimicrobial Resistance](#)
- [ReAct Toolbox](#)
 - [Video - What can you find in the ReAct Toolbox?](#)
- [ReAct Resources | Antimicrobial Resistance](#)
 - [Quiz - Antimicrobial Resistance](#)
- [ReAct Antibiotic Resistance Course: Antibiotic Resistance - The Silent Tsunami](#)
- [PHA4GE Workshop 2021 Resources](#)
- [Slides - The present and future in antimicrobial resistance surveillance](#)
- [Africa CDC | African Antibiotic Treatment Guidelines for Common Bacterial Infections and Syndromes – Final Report](#)
- [African Union | Framework for Antimicrobial Resistance Control 2020–2025](#)
- [NIH | NLM Article - Social, cultural and economic aspects of antimicrobial resistance](#)
- [ScienceDirect Article - Antimicrobial resistance: Impacts, challenges, and future prospects](#)
- [Nature Reviews Article - The role of vaccines in combatting antimicrobial resistance](#)
- [Nature Reviews Article - A guide to vaccinology: from basic principles to new developments](#)
- [WHO | Vaccines Explained Series](#)
- [HHS | Vaccine Types](#)
- [WHO | The different types of COVID-19 vaccines](#)
- [Europe PMC | How unequal vaccine distribution promotes the evolution of vaccine escape](#)
- [F1000Research | Development of vaccines for SARS-CoV-2](#)
- [Springer Nature Article - Using next generation antimicrobials to target the mechanisms of infection](#)
- [NIH | NLM Article - Antibiotic Cycling Affects Resistance Evolution Independently of Collateral Sensitivity](#)
- [Biorxiv Article - hAMRonization: Enhancing antimicrobial resistance prediction using the PHA4GE AMR detection specification and tooling](#)
- [AMR Review | Tackling Drug-Resistant Infections Globally](#)
- [WHO | Global action plan on antimicrobial resistance](#)
- [UNEP | Preventing the Next Pandemic: Zoonotic Diseases and how to Break the Chain of Transmission](#)
- [SEQAFRICA Virtual Training Course: Antimicrobial Resistance - Introduction to WGS in AMR](#)
 - [Video - Introduction to online tools: Kmers, MLST and Serotyping](#)
 - [Slides - Introduction to online tools: Kmers, MLST and Serotyping](#)
 - [Slides - CGE Online Bioinformatics Tools](#)
 - [Video - CGE Online Bioinformatics Tools](#)
 - [Video - Online Tools for Genomic Surveillance](#)
 - [Slides - Bioinformatics Basics for AMR](#)
 - [Video - Bioinformatics Basics for AMR](#)
 - [Slides - Basic Quality Control of Raw Reads](#)
 - [Video - Basic Quality Control of Raw Reads](#)
 - [Basic quality control of raw reads using FastQC + Exercise 5E \(FASTQs for QC\)](#)
 - [Using online tools for analysis of WGS data + Exercise 9E \(Isolates 1-4\)](#)

- [PHA4GE Joint AMR Workshop 2021](#)
 - [Video - Comparing and reporting AMR prediction results](#)
 - [Slides - Comparing and reporting AMR results using hAMRonization](#)
 - [GitHub - hAMRonization](#)
 - [Video - Reads to AMR reports \(practical demo\)](#)
 - [Slides - Reads to AMR reports \(practical demo\)](#)
- [SEQAFRICA Virtual Training Course: Antimicrobial Resistance - Introduction to WGS in AMR](#)
 - [Video - Practical examples of genomic surveillance: Enteric pathogens](#)
 - [Video - Practical examples of genomic surveillance: Genomic and metagenomics based surveillance of AMR in the United States under the National Antimicrobial Resistance Monitoring System \(NARMS\)](#)
 - [Video - Practical examples of genomic surveillance: WGS surveillance in Europe](#)
 - [Video - WHO: Integrated surveillance of AMR and the ESBL Ectricycle project](#)
- [Slides - Integrated Surveillance of AMR and AMU: A One Health Approach](#)
- [US CDC Video - Combating AMR Together: CDC's Global Antimicrobial Resistance Laboratory and Response](#)
- [WHO Publication - Bacterial priority pathogens list - 2024](#)
- [Africa CDC PGI Webinar Series - Pathogen Genomic Surveillance in Africa: Genomic Surveillance of M.tuberculosis in Ghana and West Africa](#)
- [WHO Guide - National antimicrobial resistance surveillance systems and participation in the Global Antimicrobial Resistance Surveillance System \(GLASS\): A guide to planning, implementation, and monitoring and evaluation](#)
- [NIH | NLM Article - Systematic review of surveillance systems for AMR in Africa](#)
- [WHO Handbook - Implementation handbook for national action plans on antimicrobial resistance: guidance for the human health sector](#)
- [NIH | NLM Article - The Ethical Significance of Antimicrobial Resistance](#)
- [NIH | NLM Article - Control of Antimicrobial Resistance Requires an Ethical Approach](#)
- [ReAct Article - The ethics of antibiotic resistance](#)
- [CMI Article - Impact of antibiotic restrictions: the ethical perspective](#)
- [BMJ Global Health Article - Interventions to address antimicrobial resistance: an ethical analysis of key tensions and how they apply in low- income and middle-income countries](#)



References

- OpenAI. (2024). Gemini response on learning objectives for an introduction to antimicrobial resistance (AMR) module. Retrieved July 29, 2024, from Gemini
- OpenAI. (2024). ChatGPT 4o mini response on learning objectives for introduction to antimicrobial resistance (AMR) module. Retrieved July 29, 2024, from ChatGPT
- OpenAI. (2024). Claude 3.5 Sonnet response on learning objectives for introduction to antimicrobial resistance (AMR) module. Retrieved July 29, 2024, from Claude
- OpenAI. (2024). Copilot response on learning objectives for an introduction to antimicrobial resistance (AMR) module. Retrieved July 29, 2024, from Copilot
- OpenAI. (2024). ChatGPT 4o mini response on shortening or rephrasing the module overview (of G09) to 3 sentences but keeping an academic tone. Retrieved November 18, 2024, from ChatGPT



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