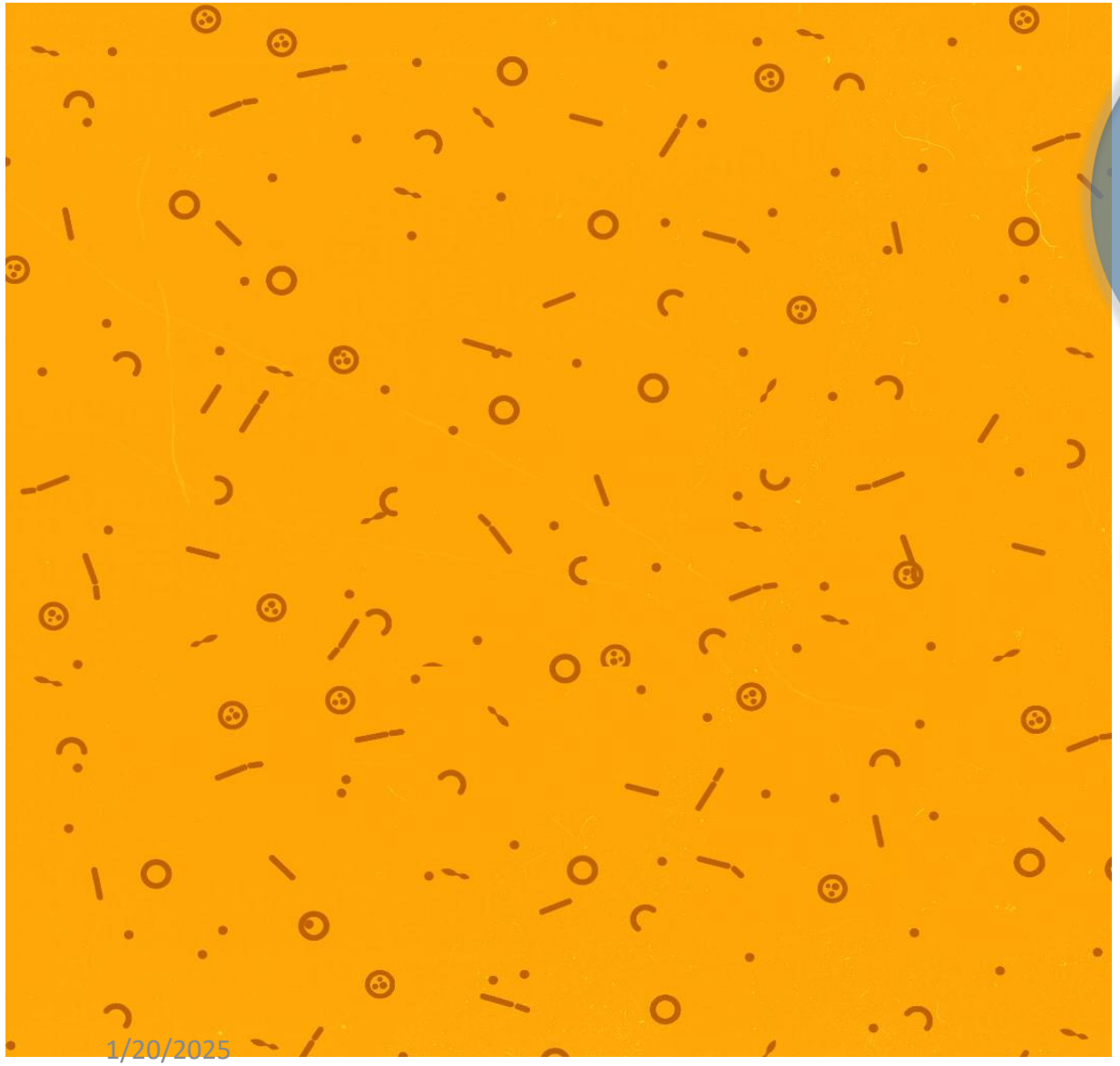
World Antimicrobial Resistance Awareness Week:

One health & Omics approaches

Antimicrobial resistance (AMR)



Inappropriate use of antimicrobials

Emergence of antimicrobial resistance

Growing resistance

4.95 million deaths per year

World-wide public health threat

World is running out of effective antimicrobials

10 million annual deaths globally by 2050

Introduction

In **May 2015** at the Sixty-eighth World Health Assembly a global action plan to tackle the growing problem of resistance to antibiotics and other antimicrobial medicines was endorsed

One of the key objectives of the plan is to **improve awareness and understanding of AMR** through effective communication, education and training

An annual event that takes place between **November 18th and November 24th** each year

The World AMR Awareness Week (WAAW))

History

1st & 2nd Event	3rd Event	4th & 5th Event	6th Event	7th Event	8th & 9th Event	10th Event
2015 & -16	2017	2018 & -19	2020	2021	2022 & -23	2024
Antibiotics: Handle with Care	Seek advice from a qualified healthcare professional before taking antibiotics		Handle with care: United to preserve antimicrobials	Spread Awareness, Stop Resistance	Preventing Antimicrobial Resistance Together	Educate. Advocate. Act now.

Will you "Go blue for AMR"?

An individual

Wear light blue when participating in WAAW events.

Adjust your social media profiles to blue.

Share why you are Going Blue with friends, family, colleagues, and on social media (Twitter, Instagram, Facebook).

A community

Organise an AMR awareness event in your community and ask everyone to come with something blue or to wear blue . Then share on social media why it is important for your community to 'Go Blue for AMR'

Gather participants for a colour campaign photoshoot using #AMR to promote across social media channels expressing why you are "Going Blue for AMR". Join the challenge to get the most comments, questions or "likes"

Use social and/or traditional media to highlight your community's or country's commitment to addressing AMR in all sectors.

The World Antimicrobial Awareness Week is an annual event that takes place between November 18th and November 24th each year. During these days, we are reminded of the importance of increasing awareness and understanding of Antimicrobial Resistance (AMR). This initiative encourages adopting best practices among the public, One Health stakeholders, and policymakers, who all have a critical role in reducing the further emergence and spread of AMR. By working together, we can create a better-equipped world to tackle the challenges associated with AMR.

Frontiers in Antibiotics is proud to launch a new article collection highlighting the importance of the UN week. This is an occasion to reflect on the current use of antibiotics and consider the importance of antibiotic resistance and its impact on our society.

This Research Topic aims to focus on the specific impact of Antibiotic Resistance (AMR) on our planet and society in relation to the United Nations week. It will highlight the importance of the appropriate use of antibiotics in humans, animals, and plants.

Possible topics to discuss include, but are not limited to:
- One Health approach for addressing antibiotic resistance.
- New techniques such as omics and single-cell approaches for studying antibiotic resistance and heterogeneous persisters.
- Novel drug-designing approaches for combating antibacterial drug resistance.
- Antibiotic stewardship.
- Combination therapy and drug repurposing as potential strategies for combating antibiotic resistance.

This topic will accept all article types accepted under the Frontiers in Antibiotics submission guidelines.

Keywords: One Health approach, Omics and single-cell approaches, Novel drug-designing, Combination therapy, Antibiotic stewardship

Possible topics

- ✓ Antibiotic stewardship
- ✓ Novel drug-designing approaches
- ✓ Combination therapy
- ✓ One Health approach
- ✓ Omics and single-cell approaches

One Health approach

A joint effort of various disciplines that come together to provide solutions for human, animal, and environmental health

One Health approach

One Health is a collaborative, multisectoral, and transdisciplinary approach — working at the local, regional, national, and global levels — with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment

One Health is not new, but it has become more important in recent years because many factors have changed interactions between people, animals, plants, and our environment

- Human populations are growing and expanding into new geographic areas. As a result, more people live in close contact with wild and domestic animals, both livestock and pets. Close contact with animals and their environments provides more opportunities for diseases to pass between animals and people.
- The earth has experienced changes in climate and land use, such as deforestation and intensive farming practices. Disruptions in environmental conditions and habitats can provide new opportunities for diseases to pass to animals.
- The movement of people, animals, and animal products has increased from international travel and trade. As a result, diseases can spread quickly across borders and around the globe.

What are common One Health issues?

Antimicrobial-resistant germs

Vector-borne diseases

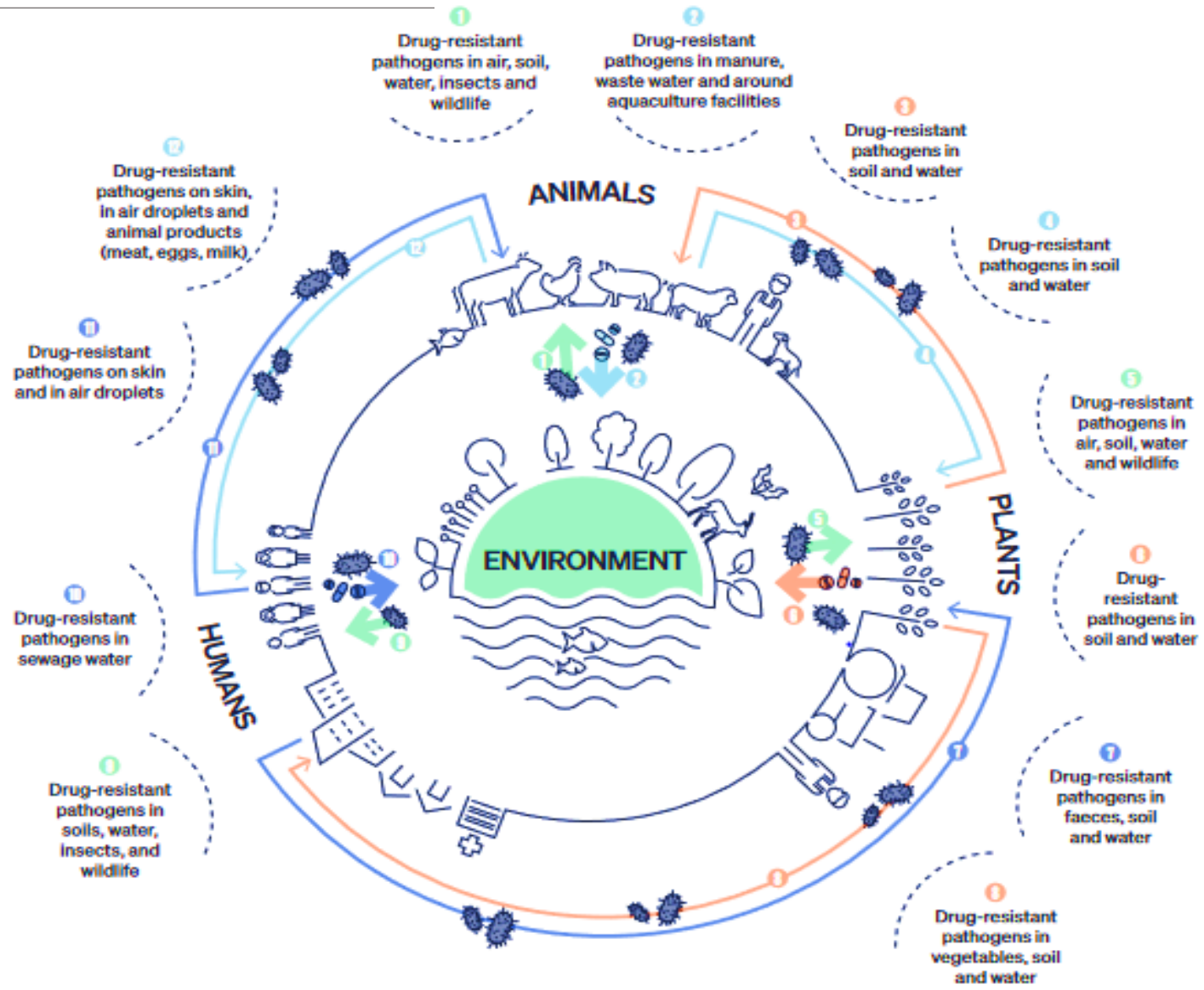
Diseases in food animals

Human-animal bond

Contamination of water

Antimicrobial resistance: a One Health challenge

Implementing One Health to fight AMR, ensuring cooperation among animal health, public health, environment, agriculture, finance and the private sector, as well as non-governmental organizations and civil society.



AMR is linked to each of these three components due to the irresponsible and excessive use of antimicrobials in various sectors

OIE: The World Organisation for Animal Health

WHO: Worldwide Health Organisation

FAO: Food and Agriculture Organization of the United Nations

Have joined forces to develop a Global Action Plan on AMR

Five main pillars to help combat AMR

Improving public awareness about antimicrobial resistance

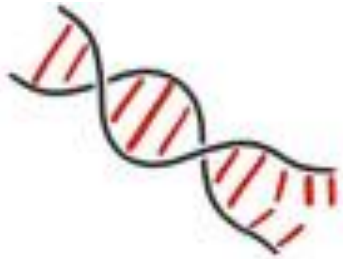
Discourages the use of antibiotics for any other non-therapeutic use

Strengthen global surveillance and further research into antimicrobial resistance

Emphasises the use of preventive measures

An economic approach that focuses on creating an enabling environment to combat the spread of antimicrobial resistance

Omics approaches

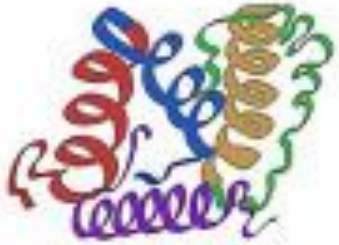


Genomics

Epigenetics
Allelic variants
Mutations

Transcriptomics

MicroRNA
Alternative splicing
RNA structure



Proteomics

Conformation
Activation
Posttranslational modifications
Secretion

Metabolomics

Transport
Enzyme kinetics
Interconversion
Accumulation
Degradation

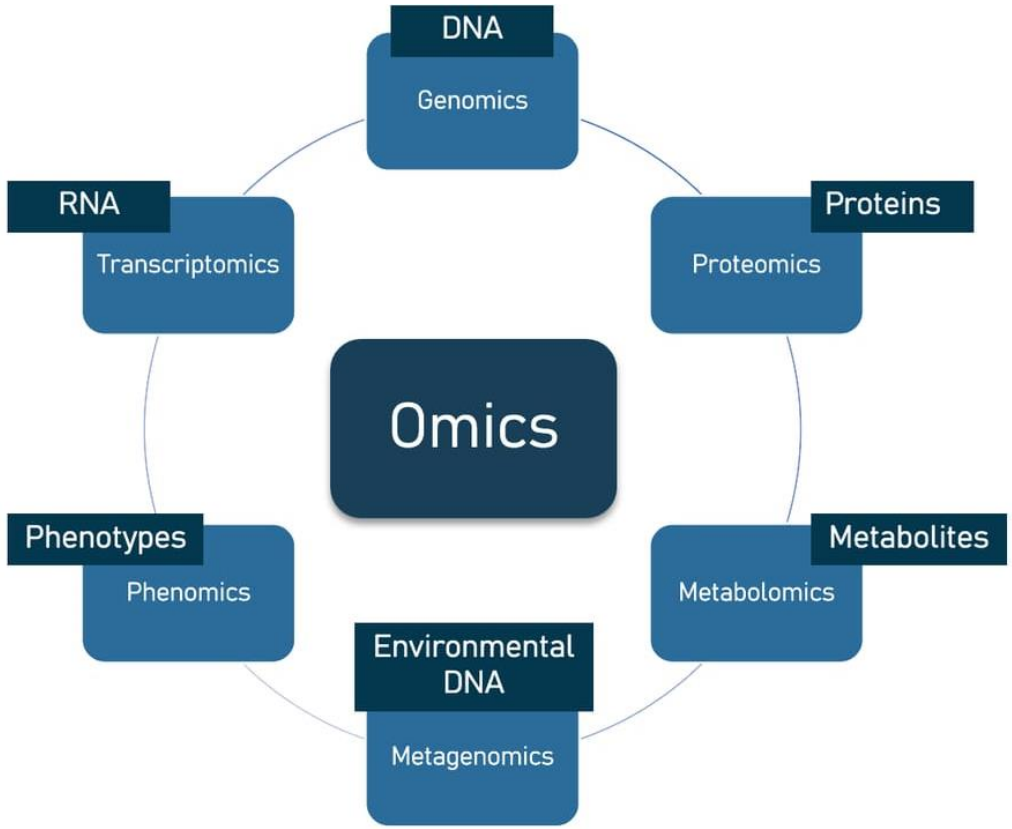
Omics cascade

Systems biology

Omics approaches

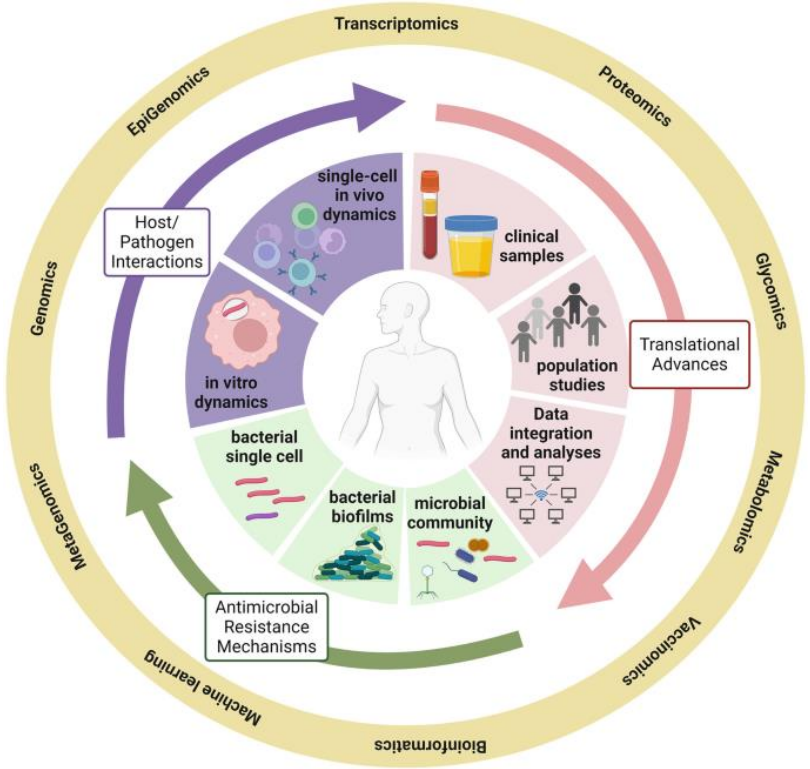
What is omics?

The word omics refers to a field of study in biology ending in the suffix –omics such as genomics, proteomics, metabolomics, metagenomics, phenomics and transcriptomics.
Omics aims at the collective characterization and quantification of pools of biological molecules that translate into the structure, function, and dynamics of an organism or organisms.



How Omics Technologies Can Assist in Combating Antibacterial Resistance

1. Understanding Mechanisms of Resistance
2. Identifying Novel Therapeutic Targets
3. Accelerating Drug Discovery
4. Enhancing Diagnostic Capabilities
5. Evaluating Antibiotic Resistance Genes (ARGs)



Genomics in AR

Helps identify mutations and genetic elements associated with antibiotic resistance

Microb Genom. 2020 Mar 2;6(3):e000344. doi: 10.1099/mgen.0.000344

Trends in *Helicobacter pylori* resistance to clarithromycin: from phenotypic to genomic approaches

Andreia T Marques [1], Jorge M B Vítor [1,2], Andrea Santos [3], Mónica Oleastro [3], Filipa F Vale [1,*]

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PMCID: PMC7200067 PMID: 32118532

- The primary mechanism of resistance is mutations in the 23S rRNA gene
  - **A2142G**
  - **A2143G**
  - **A2142C**
- Mutations in the **23S rRNA gene** Identified by NGS:
  - **G2195A** and **G2195T**
  - **A2116G** and **A2116C**

Detection of Low-Level Resistance: One of the major advantages of NGS is its ability to detect mutations even at low frequencies, including heteroresistance

Comprehensive Mutation Profiling: Providing a more comprehensive profile of mutations across the genome, beyond just those in the 23S rRNA gene. This helps to uncover other potential genetic factors that may contribute to resistance, though these are still being studied.

Identification of Novel Mutations: uncovering additional mutations or genetic alterations that contribute to clarithromycin resistance but have not yet been widely recognized or studied

Transcriptomics in AR

Descri

- **Gen** anti
- Anti **path**
- Diff **enz**

Techni

- RNA

Indian J Med Microbiol. 2019 Apr-Jun;37(2):173-185. doi: 10.4103/ijmm.IJMM_18_311.

RNA-seq analysis reveals resistome genes and signalling pathway associated with vancomycin-intermediate *Staphylococcus aureus*

Devika Subramanian [1], Jeyakumar Natarajan [1]

Affiliations + expand

PMID: 31745016 DOI: 10.4103/ijmm.IJMM_18_3

25 Key Genes: Out of the 99 genes identified, 25 were either known or novel and were confirmed to play a significant role in antibiotic resistance. These genes contribute to the development of resistance to multiple antibiotics

Agr System: The study found that the *agr* genes, which are part of the quorum sensing system that regulates virulence, were included in the resistome. This supports the hypothesis that the *agr* system is involved not only in virulence but also in the regulation of antibiotic resistance

Virulence Factors: Several genes linked to virulence, including those involved in biofilm formation and cell wall synthesis, were part of the resistome, suggesting a connection between resistance mechanisms and virulence in *S. aureus*

Application:

- Identifying potential drug targets or biomarkers of resistance
- Understanding how bacteria respond to antibiotic stress and identifying key regulatory pathways involved in resistance mechanism

Proteomics in AR

Indian J Med Res. 2015 Jan;141(1):27–45. doi: 10.4103/0971-5916.154492

Comparative proteomic analysis of sequential isolates of *Mycobacterium tuberculosis* from a patient with pulmonary tuberculosis turning from drug sensitive to multidrug resistant

Amit Singh [1,¶], Krishnamoorthy Gopinath [1,¶,†], Prashant Sharma [2], Deepa Bisht [2], Pawan Sharma [3,†,†], Niti Singh [4], Sarman Singh [1,#,✉]

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PMCID: PMC4405938 PMID: 25857493

Reported the determination of 27 proteins in clinical isolates of *M. tuberculosis* whose abundance was specifically increased in MDR isolates

Metabolomics and AR

Comparative Study > Microb Biotechnol. 2017 Nov;10(6):1764-1774.
doi: 10.1111/1751-7915.12839. Epub 2017 Aug 16.

Comparative metabolomics revealing Staphylococcus aureus metabolic response to different antibiotics

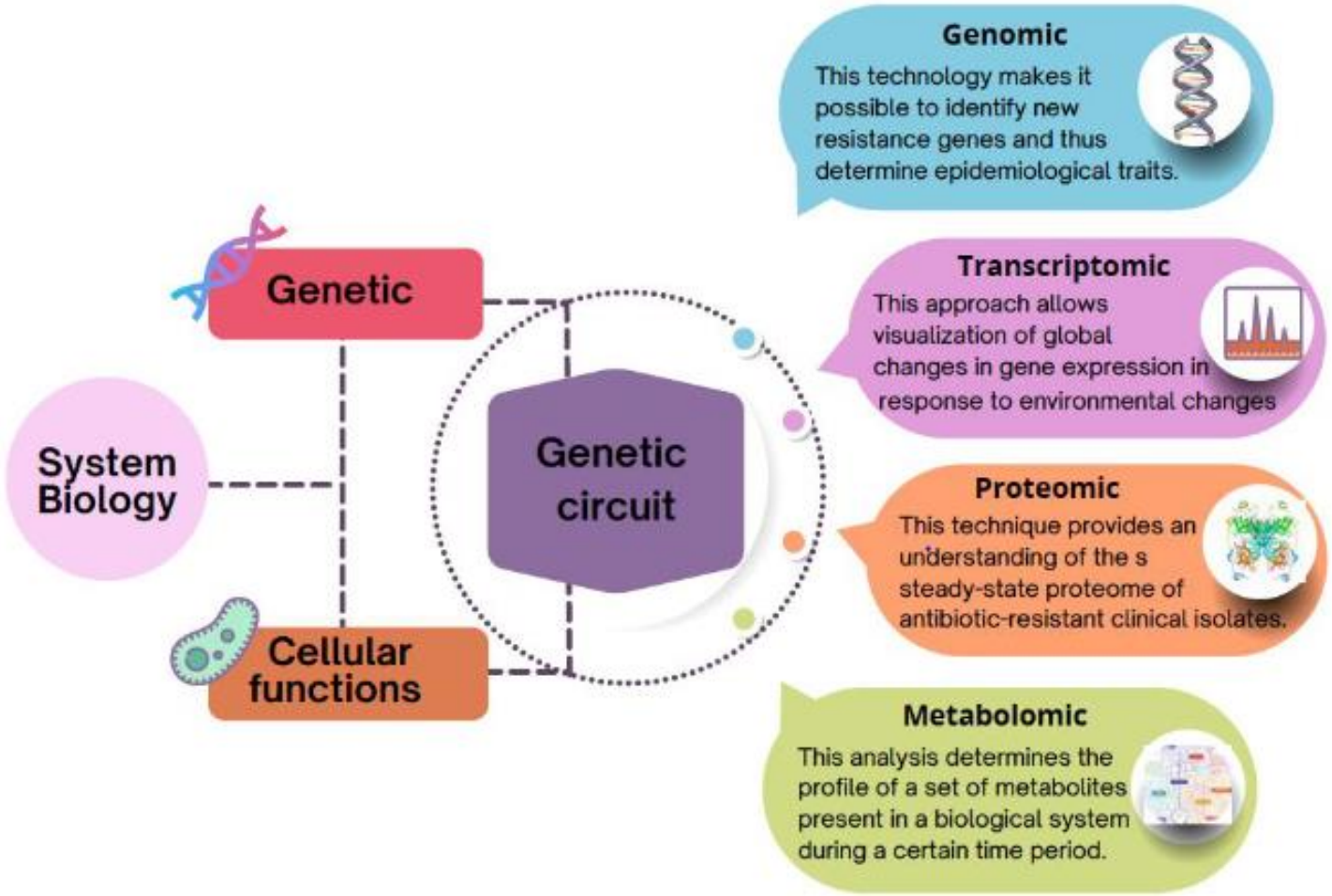
Katie Schelli [1], Fanyi Zhong [1], Jiangjiang Zhu [1]

Affiliations + expand

PMID: 28815967

The authors reported that depending on the presence or absence of methicillin, there were more metabolic variations between the two strains in the different antibiotics, especially in the metabolism of amino acids, pyrimidines, and purines. In addition, the authors observed metabolic differences between the two isolates in the presence of the same antibiotic, suggesting that the susceptible and resistant strains have a different stress response mechanism

Systems Biology Approaches:



- Utilizing systems biology frameworks that combine omics data with computational modeling can enhance our understanding of bacterial behavior in response to antibiotics, potentially leading to more effective treatment strategies

Schematic representation of the genetic circuitry that interconnects the relationship between genetics and cellular functions in a multilayered hierarchy

Application and advantages:

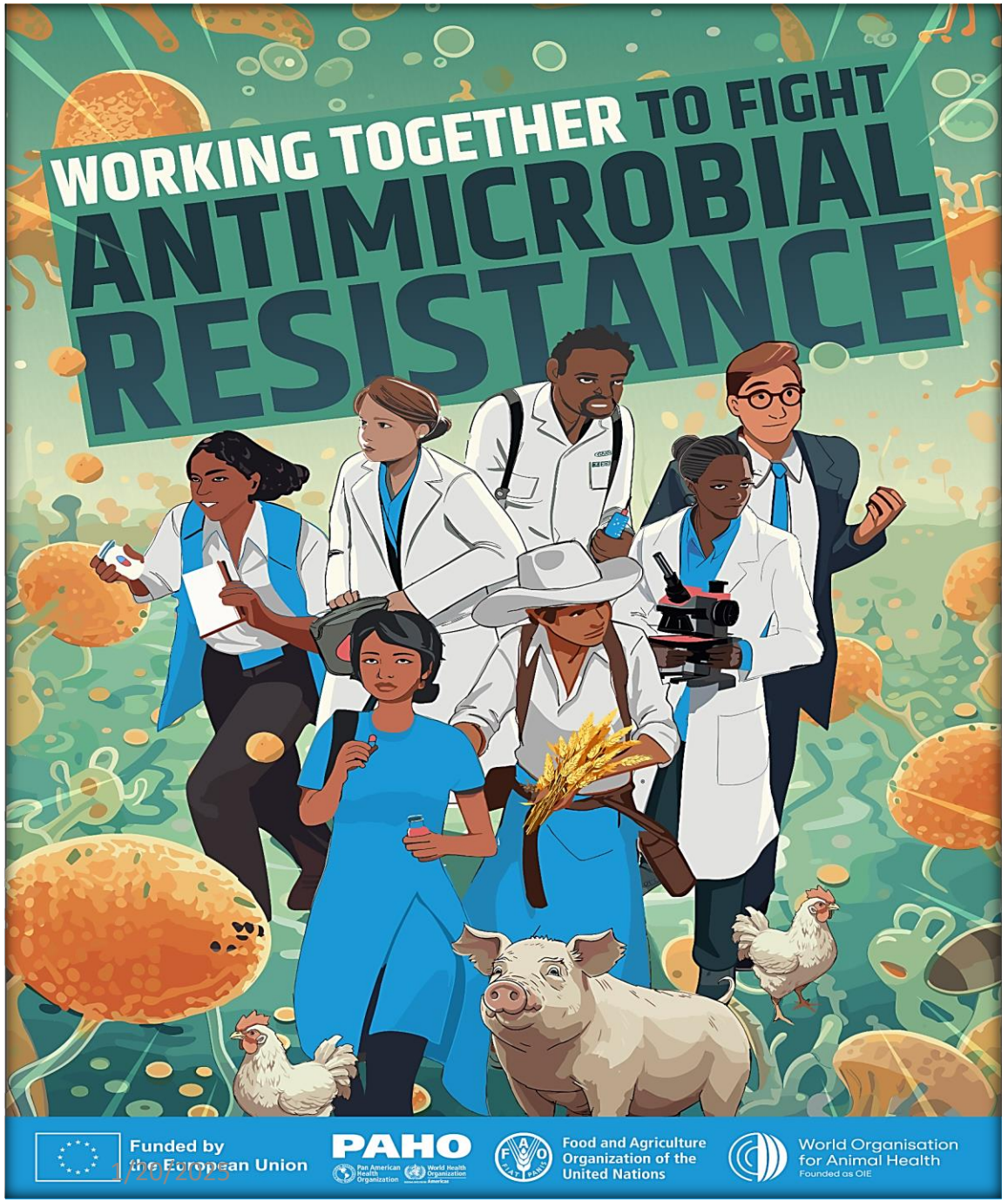
•**Omics technologies** provide a comprehensive, integrated view of **antibiotic resistance** at the molecular, genetic, and metabolic levels

•**Systems biology** allows us to understand the complexity of resistance mechanisms and predict bacterial behavior in response to antibiotics

•**Clinical and therapeutic potential**: Omics can guide personalized medicine, improve diagnostics, and drive the discovery of new drugs to fight antibiotic resistance

Challenges and Limitations of Omics Approaches

- **Data complexity**: Omics data can be vast and difficult to analyze
- **Cost**: High-throughput sequencing and analysis can be expensive
- **Reproducibility**: Ensuring consistent results across different conditions and labs
- **Need for validation**: Experimental validation of omics findings is crucial



Thanks ☺

Any question?