One Health Approach to
Antimicrobial Resistance
A Veterinary Perspective

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Preface

Antimicrobial resistance (AMR) has emerged as a formidable global health challenge, threatening to undermine our ability to treat common infections. The indiscriminate use of antibiotics in both human and veterinary medicine has accelerated the development of drug-resistant bacteria, jeopardizing public health and food security. This handbook, "Vet's View: Understanding Antimicrobial Resistance", is designed to serve as an informative resource for field veterinarians, empowering them to play a crucial role in addressing this pressing issue.

The livestock sector, a vital component of global food production and human health, is intrinsically linked to the emergence and spread of AMR. The overuse and misuse of antibiotics in animal husbandry, including their use as growth promoters and for the treatment of infections, contribute to the selection and proliferation of resistant bacteria. These resistant bacteria can then spread to humans through direct contact with animals, consumption of contaminated food products, or through the environment. The indiscriminate use of antibiotics in animal feed can also contribute to the development of AMR, as it can lead to the selection of resistant bacteria in the gut microbiota of animals.

Recognizing the interconnectedness of human, animal, and environmental health, the "One Health" approach emphasizes the need for collaborative efforts between veterinary, human, and environmental health sectors to combat AMR. Veterinarians, as stewards of animal health, are uniquely positioned to promote responsible antibiotic use, implement effective infection prevention and control measures, and advocate for prudent antibiotic stewardship programs. By understanding the factors contributing to AMR in farm animals, veterinarians can make informed decisions about antibiotic use and implement strategies to minimize the development and spread of resistance.

This handbook also provides an overview of global and national initiatives aimed at addressing AMR, including the World Health Organization's (WHO) Global Action Plan on Antimicrobial Resistance and India's National Action Plan on Antimicrobial Resistance. Additionally, it delves into the specific actions being taken in the state of Kerala to combat AMR in the livestock sector. By understanding the global and national context of AMR, veterinarians can appreciate the importance of their role in addressing this issue and can collaborate with other stakeholders to implement effective control measures.

By understanding the intricacies of AMR and the role veterinarians play in its mitigation, we can work together to preserve the efficacy of antibiotics and safeguard public health for future generations. This handbook is intended to be a valuable tool for field veterinarians, providing them with the knowledge and tools they need to promote responsible antibiotic use, implement effective infection prevention and control measures, and contribute to the fight against AMR. It is hoped that this handbook will empower veterinarians to take a proactive role in addressing AMR and to educate farmers and other stakeholders about the importance of responsible antibiotic use.

Dr. Deepthi Vijay and Dr. B. Sunil

Scan here to get the information on….

AWaRe classification of antibiotics

WHO Global Action Plan on Antimicrobial Resistance

FAO action plan on antimicrobial resistance

OIE Strategy on AMR and prudent use of antimicrobials

National action plan on antimicrobial resistance

Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP)

WOAH list of antimicrobial agents of veterinary importance

DAHD (GoI): Standard veterinary treatment guidelines for livestock and poultry

Background

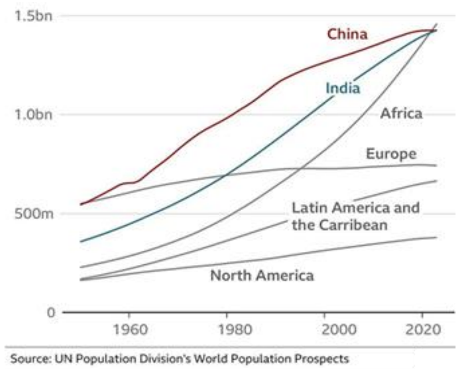
Global population and food demand

- The human population is projected to reach 9.8 billion by 2050, with an annual increase of approximately 83 million people[1]. By then, the world will need a 60% increase in food production to meet the demands of a projected 10 billion people[2]. This demand comes amidst accelerating climate change, which places significant pressures on resources, agricultural sustainability, and food systems globally.

Food and Agriculture Organization (FAO) production outlook, projections indicate a significant increase in global demand for animal-based foods from 2010 to 2050: **meat demand is expected to rise by 70%, aquaculture by 90%, and milk by 55%.**[5]

India's population growth and economic expansion

- India accounts for 18% of the global population and its population is expected to grow to 1.66 billion by 2050[3]. This demographic expansion, coupled with the nation's economic growth trajectory, highlights India's role in the global food and agricultural landscape. By 2027-2028, India aims to become a USD 5 trillion economy while promoting inclusive growth[4]. This economic advancement enhances purchasing power and heightens demand for nutritious food, particularly animal protein, which remains essential for human health. Consequently, the increasing demand for animal-based protein sources has spurred growth in organized, large-scale animal farms adopting technological innovations to meet production needs.



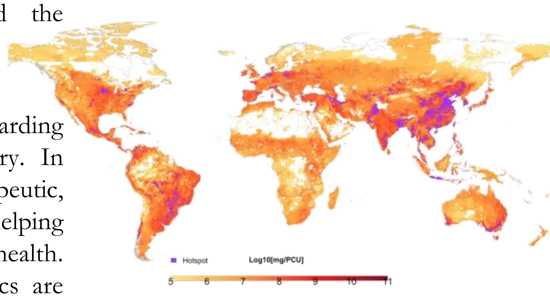
India's population double since 1950[6]

The shift toward sustainable animal production

- With expanding organized animal farming systems, sustainable animal production has become crucial for securing food safety and security to support a growing population. Sustainability in this context involves optimizing animal health and welfare, reducing environmental impact, and adopting efficient farming practices. Veterinary professionals play a key role in this endeavor by ensuring animal health through preventative care, disease management, and the responsible use of antibiotics in livestock.

Role of antibiotics in animal husbandry

- Antibiotics have been instrumental in safeguarding human and animal health since their discovery. In animal husbandry, antibiotics serve therapeutic, prophylactic, and metaphylactic purposes, helping manage disease outbreaks and promoting herd health. However, the misuse and overuse of antibiotics are emerging as critical concerns, especially at the human-animal-environment interface. Non-judicious use of antibiotics in farm animals contributes to the rise of antibiotic-resistant bacteria, which poses serious health risks across species barriers.



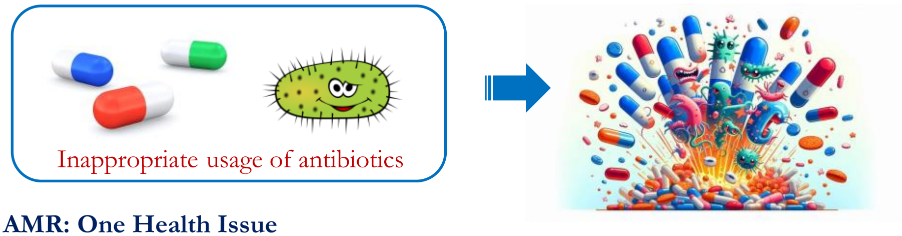
Global distribution of veterinary antimicrobial consumption at 10 x 10 kilometers resolution expressed in milligrams per biomass (population correction units).Purple indicates hotspot areas (top 95% percentile).[7]

What is Antimicrobial Resistance (AMR)?

Antimicrobial resistance (AMR) refers to the ability of microbes—such as bacteria, viruses, fungi, and parasites—to resist the effects of drugs that once effectively treated infections caused by these organisms. AMR is an evolutionary process where microorganisms adapt over time, developing mechanisms to withstand antibiotics, antivirals, antifungals, and antiparasitics.

What is Antibacterial Resistance?

Antibacterial resistance, a subset of AMR, specifically involves bacteria becoming resistant to antibiotics. While antibacterials and antibiotics were designed to combat bacterial infections, their misuse, overuse, and inappropriate prescriptions have accelerated the development of bacterial resistance, diminishing their efficacy and jeopardizing public health.

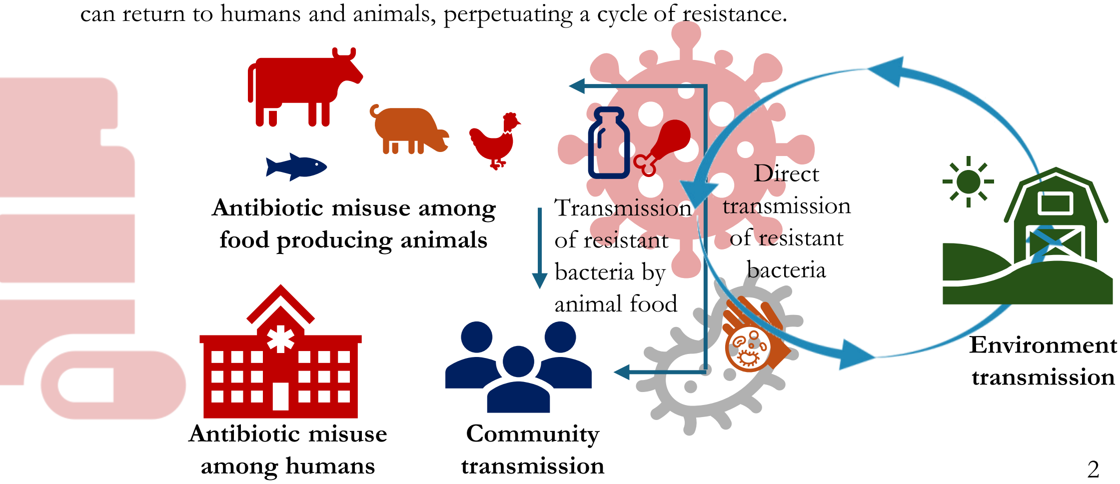


Rise of antimicrobial resistant bacteria

AMR: One Health Issue

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. The World Health Organization (WHO) has identified AMR as one of the top ten global health threats. The consequences of AMR are multifaceted, impacting **human health, animal health**, and **environmental health**[8]:

- **Human health**: Drug-resistant infections in humans lead to prolonged hospital stays, more expensive treatments, and higher mortality rates. Diseases once considered manageable are becoming harder to treat, creating a potential post-antibiotic era where minor infections and routine surgeries could become life-threatening.
- **Animal health**: In veterinary medicine, antibiotics are essential for preventing and treating infections in livestock and companion animals. However, resistant infections in animals threaten animal welfare, limit treatment options, and reduce productivity in food-producing animals, ultimately impacting food security.
- **Environmental health**: The environment is a critical reservoir and transmission pathway for antimicrobial-resistant bacteria. Antibiotics and resistant bacteria enter soil and water systems through agricultural runoff, wastewater from healthcare facilities, and improper disposal. This environmental contamination propagates resistance genes among bacteria in soil and water, which can return to humans and animals, perpetuating a cycle of resistance.



Global burden of AMR

A SILENT PANDEMIC

In 2019

Researchers estimated **4·95 million** deaths *associated* with bacterial AMR, including **1·27 million** deaths *attributable* to bacterial AMR.[9]

A child dies every three minutes from sepsis caused by multidrug-resistant organisms (MDROs).

By 2030

Projections indicate that if AMR remains unchecked, it could push an estimated **24 million** people into extreme poverty, with the majority affected in lower- and middle-income countries.[10]

By 2050

AMR could lead to **10 million** deaths annually, incur an additional **USD 1 trillion** in healthcare costs, and cause a **7.5% decline** in global livestock production.[10]

It can take **10-15 years** and over **$1 billion** to develop a new antibiotic.

Major factors contributing to AMR

- Overuse and misuse of antimicrobials
- Poor access to quality medicines, vaccines and diagnostics
- Poor infection prevention and control
- Lack of clean water, sanitation and hygiene (WASH)
- Lack of new antibiotics
- Animal husbandry practices
- Globalization and trade
- Poor public awareness

Mechanism of Antimicrobial Resistance (AMR)

Antimicrobial resistance (AMR) occurs when microbes evolve mechanisms to resist drugs that once effectively targeted them. Bacteria, the most common cause of AMR, develop resistance either through **mutation** or **acquisition of new genetic material**. These mechanisms allow bacteria to neutralize drugs, limit drug entry, expel the drug, or alter the drug's target within the bacterial cell. Here's an overview of the two primary ways bacteria acquire resistance and their specific defense mechanisms.

Resistance by mutation

Mutations are random changes in the bacterial DNA that can lead to resistance. These mutations typically occur during DNA replication and can be selected under antibiotic pressure. If a mutation provides survival benefits, such as reducing the effectiveness of a drug, it is likely to proliferate within a bacterial population.

Example: Fluoroquinolone resistance: Mutations in the *gyrA* gene change DNA gyrase, a key enzyme, preventing fluoroquinolones from binding and halting DNA replication.

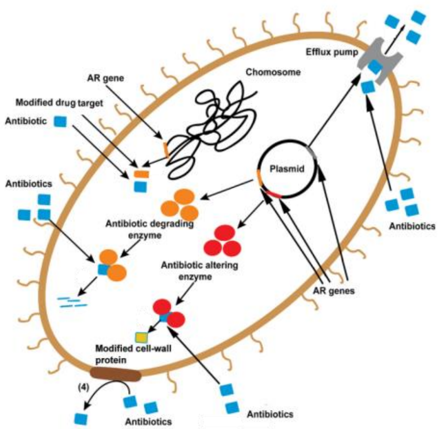
Acquisition of new genetic material

Bacteria can acquire genes from other resistant bacteria through horizontal gene transfer (HGT), which occurs via conjugation, transformation, or transduction. This method is particularly effective for spreading resistance, as it allows rapid adaptation to antibiotic pressure.

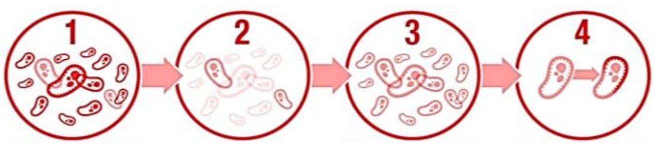
Example: Extended-spectrum β-lactamase (ESBL)-producing *Escherichia coli*: ESBL-producing *E. coli* acquire genes like *bla_CTX-M*, enabling them to break down a broad range of β-lactam antibiotics.

Types of defense mechanisms in resistant bacteria

Mechanism	Description
Enzyme production	Resistant bacteria produce enzymes that inactivate or degrade the antibiotic. E.g., *E. coli* with β-lactamase enzymes (e.g., ESBLs)
Efflux pumps	Bacteria use efflux pumps to actively expel antibiotics, reducing intracellular drug concentration. E.g., *Pseudomonas aeruginosa* with multidrug efflux pumps
Altered target sites	Bacterial target molecules are modified to prevent antibiotic binding, reducing drug effectiveness. E.g., MRSA with altered penicillin-binding proteins
Reduced permeability	Changes in cell wall or membrane proteins limit antibiotic entry, particularly effective for Gram-negative bacteria. E.g., *Klebsiella pneumoniae* with modified porins
Biofilm formation	Bacteria form biofilms, dense communities with protective layers that limit antibiotic penetration. E.g., *Pseudomonas aeruginosa*



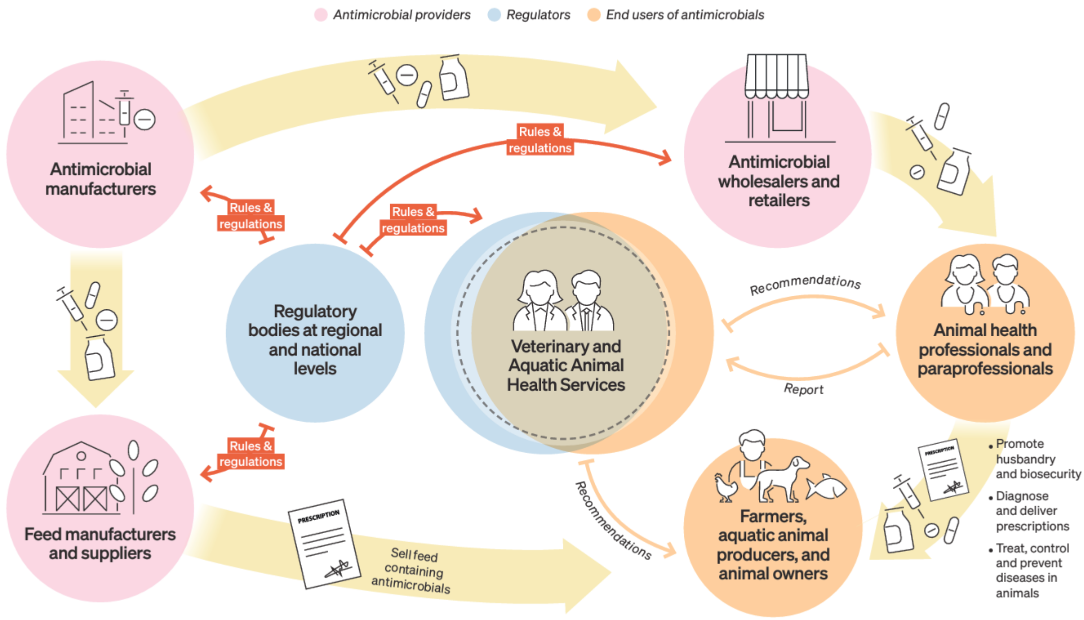
Mechanisms for developing AMR[11]



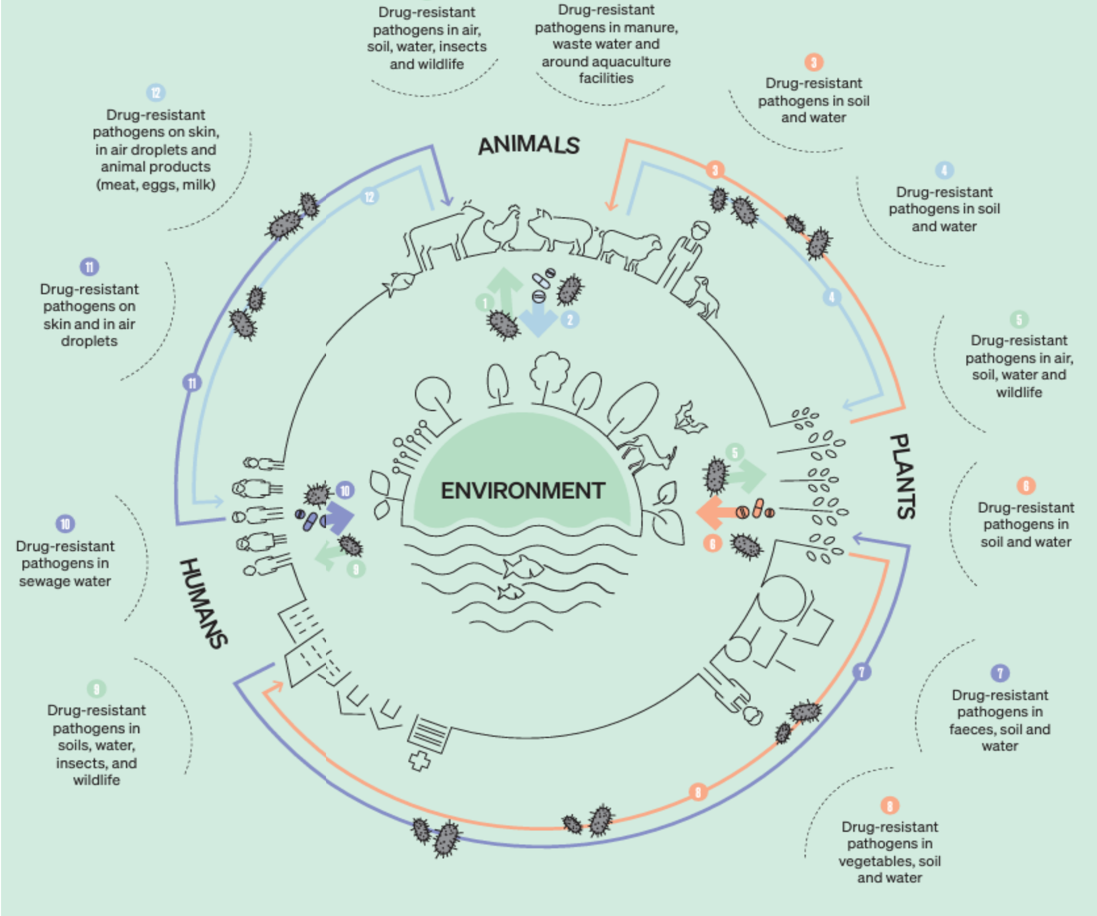
1. High number of bacteria. A few of them are resistant to antibiotics
2. Antibiotics kill sensitive bacteria causing the illness, as well as good bacteria protecting the body from infection
3. The resistant bacteria now have preferred conditions to grow and take over
4. Bacteria can even transfer their drug-resistance to other bacteria, causing more problems

World Organisation for Animal Health
Founded as OIE

Antimicrobials in animals: who does what?[12]



One Health and AMR[13]



Key factors contributing to antimicrobial resistance (AMR) in animals[14]

Factor	Description
Overuse and misuse of antibiotics	Antibiotics are frequently used preventively and as growth promoters, leading to resistance through low-dose, prolonged exposure of bacteria to antibiotics.
Poor management and hygiene	Overcrowding, poor sanitation, and limited biosecurity increase disease risk and the necessity for antibiotics to manage frequent infections.
Lack of veterinary oversight	Limited access to veterinary services results in unregulated antibiotic use by farmers without proper guidance on dosing or necessity.
Weak regulatory frameworks	Insufficient policies and regulations allow unrestricted antibiotic sales and lack of monitoring, encouraging non-therapeutic use in animals.
Environmental cross-contamination	Farm waste containing antibiotic residues contaminates soil and water, spreading resistant bacteria to wildlife and other farms.
Inadequate waste management	Improper disposal of animal waste and wastewater allows antibiotic residues to enter local ecosystems, promoting resistance spread.
Limited access to alternative treatments	Lack of affordable or accessible alternatives like vaccinations leads to reliance on antibiotics for disease prevention.
Economic pressures on productivity	Farmers under economic pressure to increase production may use antibiotics as a quick solution, favoring productivity over sustainable health management practices.
Cross-species transmission	Resistance genes can spread between animals and humans through direct contact, handling of animal products, and shared water sources, increasing zoonotic risks.
Limited education on AMR	Farmers and workers may lack awareness about antimicrobial resistance and best practices for antibiotic use, contributing to overuse and misuse.
Weak surveillance and monitoring	Absence of systematic tracking of resistance patterns and antibiotic usage in animal agriculture prevents early detection and intervention of AMR hotspots.
Frequent use of non-targeted antibiotics	Non-specific or broad-spectrum antibiotics are often used without diagnostics, allowing bacteria to develop resistance to multiple antibiotic classes.
Availability of over-the-counter antibiotics	Easy access to antibiotics without prescriptions contributes to unsupervised and excessive use.

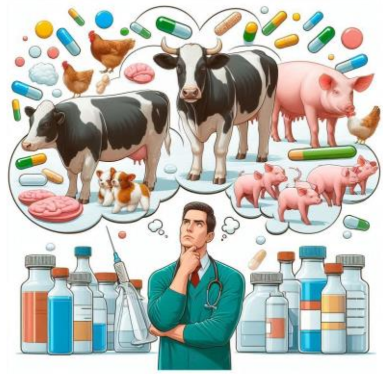
Veterinary professionals are on the frontlines in the fight against AMR, playing a crucial role in promoting the responsible use of antibiotics among animals and encouraging practices that reduce the need for antimicrobials.

Veterinarians have a unique position due to their contact with both animals and farmers, which enables them to influence sustainable farming practices that align with global standards for AMR control.

1. **Ensuring responsible antibiotic use**: Veterinarians are essential in overseeing that antibiotics are used only when necessary to control or treat infections, ensuring antibiotics are prescribed based on accurate diagnoses. By examining animals clinically before prescribing, veterinarians make informed decisions on the appropriate antimicrobial agent, considering the WOAH (World Organisation for Animal Health) list of antimicrobial agents of veterinary importance. Antibiotics are only to supplement—not replace—good husbandry, hygiene, and vaccination practices.
2. **Vaccination programs to reduce antibiotic dependency**: Vaccinating animals is a preventive measure that reduces infection risk, diminishing the reliance on antibiotics. Veterinarians facilitate immunization schedules that safeguard animal health and help prevent diseases, particularly in high-density farming, where infection risk is elevated.
3. **Promoting alternative therapies**: Veterinarians can advocate for alternative therapies, such as herbal or Ayurvedic treatments, where appropriate, as supplementary options to antibiotics. These treatments can help reduce dependence on antibiotics, especially for minor ailments, while maintaining animal welfare and productivity.
4. **Enhancing hygiene and biosecurity**: Veterinarians play a vital role in implementing hygiene practices throughout production and processing chains. Good hygiene practices at every stage—from animal rearing to processing—can significantly reduce infection risks. By advocating for improved biosecurity and stress-free animal handling, veterinarians contribute to healthier farm environments, which further reduces the need for antibiotic interventions.
5. **Supporting sustainable farming practices**: Veterinarians are instrumental in promoting sustainable farming techniques that emphasize improved hygiene, effective biosecurity, and stress-free handling. Such practices help create environments less conducive to disease outbreaks, reducing the overall need for antibiotic use.
6. **Implementing global/national/regional guidelines**: Veterinarians play a critical role in supporting the implementation of standards established by the WOAH, FAO, WHO, as well as national and regional authorities, to promote the responsible use of antibiotics. By adhering to these guidelines, veterinarians help preserve the effectiveness of antimicrobials, reduce misuse, and curb the development of resistance.
7. **Raising awareness among farmers**: Education is a fundamental tool in combating AMR. Veterinarians are well-placed to inform farmers about the dangers of AMR, correct antibiotic use, and essential biosecurity practices. By increasing awareness, veterinarians help create a cooperative approach to AMR, empowering farmers to make informed decisions about animal health management.

Points to remember before antimicrobial use in animals:

- **Use antibiotics only after a clinical examination by a veterinarian** to assess the necessity.
- **Administer antibiotics only when necessary**, prioritizing drugs on the WOAH List of antimicrobial agents of veterinary importance.
- **Ensure antibiotics complement, not replace**, good husbandry practices, biosecurity, and vaccination.
- **Select antibiotics based on clinical experience and diagnostic testing** whenever possible to maximize efficacy and minimize resistance.
- **Adhere to precise treatment protocols and withdrawal times**, ensuring antibiotics are used safely and effectively.



Field-level practices that veterinarians can adopt to further curb antimicrobial resistance (AMR), building on their essential role in promoting responsible antibiotic use:

a) **Implement regular health monitoring programs**: Establish routine health check-ups and monitoring for early detection of diseases, allowing for timely intervention with non-antibiotic treatments before infections escalate.

b) **Set up isolation protocols for sick animals**: Recommend and help implement isolation facilities for sick animals to prevent the spread of infectious diseases within the herd or flock, thus limiting the need for group antibiotic treatments.

c) **Support regular disinfection schedules**: Promote routine disinfection of animal housing, equipment, and transport vehicles to minimize the bacterial load in the environment, reducing infection risk.

d) **Promote space optimization**: Optimal stocking densities, reduce stress and exposure to pathogens, which can lower the risk of disease outbreaks and the need for antibiotics.

e) **Encourage improved feed quality and nutrition**: Work with farmers to improve the nutritional quality of animal feed, as well-nourished animals have stronger immune responses and are less susceptible to infections.

f) **Advocate for probiotic and prebiotic use**: Encourage the use of probiotics and prebiotics to maintain healthy gut flora in animals, supporting immune function and reducing the likelihood of infections that would require antibiotics.

g) **Facilitate access to rapid diagnostic tools**: Advocate for and assist with the integration of rapid diagnostic tools in the field, allowing for specific identification of pathogens and reducing unnecessary or empirical antibiotic use.

h) **Develop farm-specific biosecurity protocols**: Collaborate with farmers to create customized biosecurity protocols based on each farm's unique conditions, including risk assessments and targeted AMR reduction strategies.

i) **Promote Record-keeping for antibiotic use**: Encourage farmers to maintain detailed records of antibiotic use, including dosage, duration, and outcomes, to enable data-driven adjustments to reduce future antibiotic dependency.


ANTIMICROBIALS ARE ESSENTIAL MEDICINES
HELP PROTECT THEIR ABILITY TO FIGHT INFECTION
FOLLOW THE FIVE "Only" RULES
1
Only use antimicrobials when prescribed by a veterinarian
2
Only use when needed, antimicrobials do not cure every infection
3
Only use the dosage and follow length of treatment and withdrawal period as prescribed
x2
4
Only obtain antimicrobials from authorised sources
5
Only use when associated with good animal husbandry, vaccination and hygiene practices
WE ALL HAVE A ROLE TO PLAY, AND YOU, AS ANTIMICROBIAL USERS, CAN HELP
WE NEED YOU
OIE
WORLD ORGANISATION FOR ANIMAL HEALTH
Protecting animals, preserving our future
For more information : www.oie-antimicrobial.com

Global ACTION PLANS against Anttimicrobial Resistance

The Tripartite, a partnership between the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organisation for Animal Health (WOAH), has for many years worked together towards harmonized international standards, capacity building initiatives, and monitoring and evaluation to support responsible and prudent use of antimicrobials.

World Health Organization (WHO): Global action plan on AMR[15]

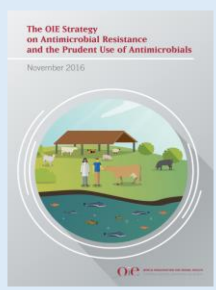
1. To improve awareness and understanding of antimicrobial resistance
2. To strengthen knowledge through surveillance and research
3. To reduce the incidence of infections
4. To optimize the use of antimicrobial agents
5. Develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines and other interventions

Food and Agriculture Organization (FAO) Action Plan on AMR[16]

1. Improving awareness on AMR and related threats
2. Developing capacity for surveillance and monitoring of AMR and antimicrobial use in food and agriculture
3. Strengthening governance related to AMR and antimicrobial use in food and agriculture
4. Promoting good practices in food and agricultural systems and the prudent use of antimicrobials

The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials[17]

1. Improve awareness and understanding
2. Strengthen knowledge through surveillance and research
3. Support good governance and capacity building
4. Encourage implementation of international standards



WHO guidelines on use of medically important antimicrobials in food-producing animals[18]

Recommendations

Overall reduction in use of all classes of medically important antimicrobials in food-producing animals (type: strong recommendation)

Justification: Reducing antimicrobial use lowers the prevalence of AMR in bacteria isolated from humans and animals. Extensive research into mechanisms of AMR, including the important role of horizontal gene transfer of AMR determinants, supports the conclusion that using antimicrobials in food producing animals selects for AMR in bacteria isolated from food producing animals, which then spread among food-producing animals, into their environment, and to humans.

Complete restriction of use of all classes of medically important antimicrobials in food-producing animals for growth promotion (type: strong recommendation)

Justification: Evidence shows that restricting growth promotion use reduces AMR in bacteria that can be transmitted to humans. Furthermore, potential undesirable consequences associated with complete restriction of growth promotion use of antimicrobials in food-producing animals (e.g. adverse effects on animal health and welfare, food safety, environment and animal production, increased costs of animal production etc) appear to be relatively small or non-existent.

Complete restriction of use of all classes of medically important antimicrobials in food-producing animals for prevention of infectious diseases that have not yet been clinically diagnosed (type: strong recommendation)

Justification: Restricting preventive use can significantly lower antimicrobial resistance in bacteria isolated from humans.

Conditional recommendations for control and treatment:

- **Recommendation a**: Suggest that critically important antimicrobials should not be used for controlling the spread of clinically diagnosed infectious diseases within a group of food-producing animals.
- **Recommendation b**: Suggest that highest-priority critically important antimicrobials should not be used for treating clinically diagnosed infectious diseases in food-producing animals.

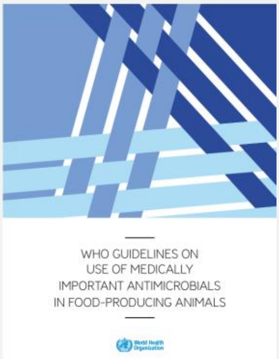
Justification: Although evidence supports the human health benefits, the quality of evidence is very low, making these recommendations conditional.

Best Practice Statements:

- **Statement 1**: Any new class of antimicrobials or new antimicrobial combinations developed for human use will be considered critically important for human medicine unless categorized otherwise by WHO.
- **Statement 2**: Medically important antimicrobials not currently used in food production should not be used in the future in food production, including in food-producing animals or plants.

Implementation considerations:

- Emphasize the need for improved hygiene, biosecurity, and vaccination strategies to reduce the need for antimicrobials.
- Highlight the importance of monitoring and surveillance programs to evaluate the impact of these guidelines.



WHO AWaRe Antibiotic Categorization

WHO developed a framework based on three different categories – Access, WAtch and Reserve – which all together forms the AWaRe categorization of antibiotics[19]

Access group	Watch group	Reserve group
• First or second choice antibiotics • Offer the best therapeutic value, while minimizing the potential for resistance	• First or second choice antibiotics • Only indicated for specific, limited number of infective syndromes • More prone to be a target of antibiotic resistance and thus prioritized as targets of stewardship programs and monitoring	• "last resort" • Highly selected patients (life-threatening infections due to multi-drug resistant bacteria) • Closely monitored and prioritized as targets of stewardship programs to ensure their continued effectiveness

Points to always consider when prescribing

1. **Diagnose** – what is the clinical diagnosis? Is there evidence of a significant bacterial infection?
2. **Decide** – are antibiotics really needed? Do I need to take any cultures or other tests?
3. **Drug (medicine)** – which antibiotic to prescribe? Is it an Access or Watch or Reserve antibiotic? Are there any allergies, interactions or other contraindications?
4. **Dose** – what dose, how many times a day? Are any dose adjustments needed, for example, because of renal impairment?
5. **Delivery** – what formulation to use? Is this a good quality product? If intravenous treatment is needed, when is step down to oral delivery possible?
6. **Duration** – for how long? What is the stop date?
7. **Discuss** – inform the patient of the diagnosis, likely duration of symptoms, any likely medicine toxicity and what to do if not recovering.
8. **Document** – write down all decisions and the management plan.

WOAH (founded as OIE) **criteria for antimicrobial agents of veterinary importance**

As per WOAH, the following criteria were selected to determine the degree of importance for classes of veterinary antimicrobial agents.[20]

- **Criterion 1.** Response rate to the questionnaire regarding Veterinary Important Antimicrobial Agents. This criterion was met when a majority of the respondents (more than 50%) identified the importance of the antimicrobial class in their response to the questionnaire.
- **Criterion 2.** Treatment of serious animal disease and availability of alternative antimicrobial agents This criterion was met when compounds within the class were identified as essential against specific infections and there was a lack of sufficient therapeutic alternatives.

On the basis of these criteria, the following categories were established:

a) Veterinary Critically Important Antimicrobial Agents (VCIA): are those that meet BOTH criteria 1 AND 2
b) Veterinary Highly Important Antimicrobial Agents (VHIA): are those that meet criteria 1 OR 2
c) Veterinary Important Antimicrobial Agents (VIA): are those that meet NEITHER criteria 1 OR 2

National Action Plan on AMR (NAP-AMR): 2017 to 2021

Ministry of Health & Family Welfare launched the National Action Plan on AMR (NAP-AMR) in 2017 which was developed in alignment with the Global Action Plan on AMR. The Action Plan is being implemented by various stakeholder Ministries. The duration of NAP AMR was for 5 years.

Strategic Priorities of NAP-AMR[21]

- Improve awareness and understanding of AMR through effective communication, education, and training
- Strengthen knowledge and evidence through surveillance
- Reduce the incidence of infection through effective infection, prevention, and control (IPC)
- Optimize the use of antimicrobial agents in all sectors
- Promote investments for AMR activities, research, and innovations
- Strengthen India's leadership on AMR by means of collaborations on AMR at international, national, and sub-national levels

Way forward: NAP-AMR 2.0

National expert consultations were held towards development of NAP-AMR 2.0 in 2022:

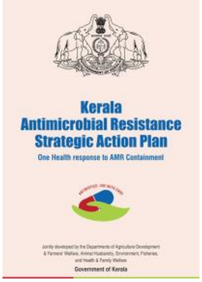
- The consultations were held for the human health sector, research sector, professional associations and civil society organizations, environment and animal husbandry sectors.
- Each consultation was attended by experts who represented with the private sector, technical institutions, professional groups, industry, cooperatives, NGOs, International partners and other relevant organisations.
- Objectives of these consultations included undertaking SWOT (Strength, Weaknesses, Opportunities and Threats) analyses across various sectors in context of the existing NAP-AMR and beyond as well as proposing the structure and contents of the proposed NAP 2.0. and to recommend essential elements of AMR research policy and research agenda of the country under NAP 2.0. For details refer Compiled report of National Expert Consultations for developing National Action Plan on Antimicrobial Resistance 2.0 (weblink: https://ncdc.mohfw.gov.in/wp-content/uploads/2024/05/Compiled-report-of-National-Expert-Consultations-for-developing-National-Action-Plan-on-Antimicrobial-Resistance-2.0.pdf)[22]

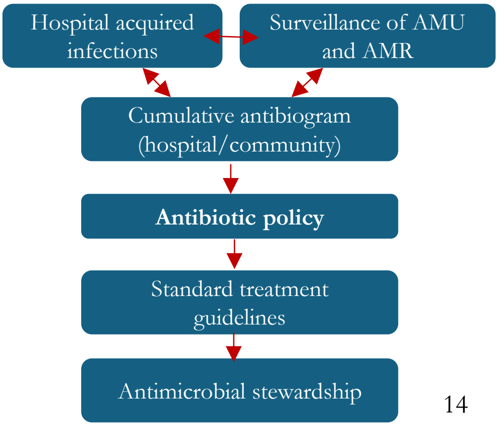
KARSAP has 6 strategic priorities and their focus areas:

Strategic priorities	Focus areas
1. Awareness and understanding	• Communication and IEC • Education and training
2. Knowledge and evidence	• Laboratories • Surveillance
3. Infection prevention and control	• IPC in human health • Animal feed and food • Environment
4. Optimizing use of antibiotics	• Regulations • Hospital and healthcare • Veterinary and aquaculture • Surveillance of AM use
5. Research and innovations	• Research • Innovations
6. Collaborations	• Public private partnerships • Disease control programs

KARSAP Initiatives

- Kerala Antimicrobial Resistance Surveillance Network (KARS-Net)
- Antibiotic Literate Kerala Campaign
- Hub and spoke model
- Antibiotic Metric Calculation to assess antimicrobial usage (AMU)
- Antimicrobial Stewardship Tool
- K-Disc- AI based antibiogram app
- Antibiotic Smart Hospitals (10-point criteria)
- PROUD (Programme on removal of unused drugs)
- Integrated AMR Surveillance plan for non-human sector
- ROAR- Range on Antimicrobial Resistance
- Operation AMRITH (Antimicrobial Resistance Intervention for Total Health)
- Operation Vetbiotic





Key Myths and Facts Veterinarians Should Know

Myth 1: Zero antibiotic use is the ideal goal.

Fact: While reducing antibiotic use is crucial, a complete elimination can be detrimental to animal health and food safety. Responsible and judicious use of antibiotics is essential for controlling infections and preventing disease outbreaks in animals.

Myth 2: Antibiotic resistance is a new problem.

Fact: Antibiotic resistance has been a problem since the discovery of antibiotics. However, the misuse and overuse of antibiotics have accelerated the development of resistant bacteria.

Myth 3: Antibiotics are primarily used for growth promotion.

Fact: The primary purpose of antibiotics in veterinary medicine is to treat infections and prevent disease outbreaks. While the use of antibiotics for growth promotion has been restricted in many countries, it's important to understand that their primary role is therapeutic.

Myth 4: Antibiotic resistance in animals is a major source of human infections.

Fact: While there is a risk of transmission of resistant bacteria from animals to humans, the primary driver of AMR in humans is the overuse and misuse of antibiotics in human healthcare settings.

Myth 5: All antibiotics used in animal agriculture are harmful to human health.

Fact: Antibiotics used in veterinary medicine are carefully regulated to ensure that they are safe for animals and do not pose a risk to human health when used correctly. Strict withdrawal periods should be enforced to ensure that antibiotic residues are not present in food products.

Myth 6: Intensive farming practices are the main cause of antibiotic resistance.

Fact: The overuse and misuse of antibiotics, regardless of the farming system, is the primary driver of antibiotic resistance. Both intensive and extensive farming systems can contribute to the problem if antibiotics are not used responsibly.

Myth 7: All antibiotics are equally effective against all bacteria.

Fact: Different antibiotics have different mechanisms of action and are effective against specific types of bacteria. It is important to use the appropriate antibiotic for the specific infection to minimize the risk of resistance development.

Myth 8: Once a bacterium becomes resistant to one antibiotic, it will be resistant to all drugs

Fact: Bacteria can develop resistance to specific antibiotics, but this does not mean they will be resistant to all antibiotics. It is important to switch the antibiotic class to treat infections and to avoid using the same antibiotic repeatedly.

Myth 9: Preventive antibiotic use is always necessary to prevent disease outbreaks.

Fact: Preventive antibiotic use should be used judiciously and only when necessary. Good biosecurity practices, vaccination, and proper hygiene can help to reduce the need for antibiotics.

Myth 10: Organic food is always free from antibiotic residues.

Fact: While organic farming practices often limit the use of antibiotics, it is important to note that organic animals can still become ill and may require antibiotic treatment. Additionally, organic food can become contaminated with antibiotic-resistant bacteria from the environment.

Myth 11: Antibiotic resistance is only a problem in developed countries.

Antibiotic resistance is a global problem that affects both developed and developing countries. In fact, the problem may be more severe in developing countries due to factors such as poor sanitation, inadequate access to healthcare, and the overuse of antibiotics.

Myth 12: Antibiotic resistance is a problem that will eventually solve itself.

Fact: Antibiotic resistance is a serious and growing problem that requires immediate action. Without effective measures to reduce antibiotic use and prevent the spread of resistant bacteria, the future of medicine could be jeopardized.

1. **ABST (Antibiotic Susceptibility Testing)**: Laboratory testing to determine which antibiotics effectively inhibit or kill specific bacteria, guiding appropriate antibiotic use.
2. **Acquired antibiotic resistance:** Resistance developed by bacteria after exposure to antibiotics, often due to genetic mutation or acquisition of resistance genes.
3. **Antimicrobial stewardship:** Policies and practices promoting responsible antimicrobial use to reduce resistance development and improve patient outcomes.
4. **Broad-spectrum antibiotics:** Antibiotics that act against a wide range of bacteria, both gram-positive and gram-negative.
5. **Carbapenem-resistant Enterobacteriaceae (CRE):** A group of bacteria highly resistant to carbapenem antibiotics, often leading to difficult-to-treat infections.
6. **Cross-resistance**: When resistance to one antimicrobial leads to resistance to related drugs, often due to shared resistance mechanisms.
7. **ESBL (Extended-Spectrum Beta-Lactamases):** Enzymes produced by certain bacteria that break down beta-lactam antibiotics, making them resistant to many penicillins and cephalosporins.
8. **Extra-label drug use (ELDU):** The use of an approved drug in a way not specified on the label, often in veterinary medicine under strict regulation.
9. **Intrinsic antibiotic resistance:** Natural resistance to antibiotics found in some bacterial species, regardless of prior antibiotic exposure.
10. **Metaphylaxis:** The administration of antibiotics to a group of animals to control and prevent disease, especially when one or more animals are diagnosed with a contagious disease.
11. **Methicillin-Resistant Staphylococcus aureus (MRSA):** A type of staph bacteria resistant to methicillin and related antibiotics, often causing challenging infections in healthcare and community settings.
12. **MIC (Minimum Inhibitory Concentration):** The lowest concentration of an antibiotic that inhibits visible growth of a microorganism, indicating its potency against specific pathogens.
13. **Multidrug-resistant (MDR):** Organisms that are resistant to multiple classes of antibiotics, making infections difficult to treat with standard therapies.
14. **NDM (New Delhi Metallo-Beta-Lactamase):** An enzyme that confers resistance to a wide range of beta-lactam antibiotics, particularly carbapenems, complicating treatment.
15. **Narrow-spectrum antibiotics:** Antibiotics effective against a limited range of bacteria, often used to target specific pathogens without disrupting other bacteria.
16. **Nosocomial infection:** Infections acquired in healthcare settings, often caused by resistant organisms due to high antibiotic usage.
17. **One health approach:** An interdisciplinary approach recognizing that human, animal, and environmental health are interconnected, essential in addressing AMR.
18. **Pan-drug-resistant (PDR):** Organisms resistant to all known classes of antibiotics, making infections almost impossible to treat with current drugs.
19. **Pharmacokinetics:** The study of how a drug is absorbed, distributed, metabolized, and eliminated in the body, crucial for understanding antibiotic effectiveness.
20. **Prophylactic use of antibiotics:** Administration of antibiotics to prevent rather than treat infection, particularly in high-risk situations.
21. **Resistance profile:** The spectrum of resistance a microorganism has to various antibiotics, guiding effective treatment choices.
22. **Selective pressure:** The environmental factors, such as antibiotic use, that encourage the survival of resistant organisms over susceptible ones.
23. **Sub-therapeutic antibiotic treatment (STAT):** Administration of low antibiotic doses, not enough to treat infection but often used to promote growth or prevent disease in livestock, contributing to resistance.
24. **Superbugs:** Informal term for multidrug-resistant bacteria that are difficult to treat with available antibiotics.
25. **Withdrawal period:** The required time for antibiotics to be metabolized and cleared from an animal's system before its products (milk, meat) are deemed safe for consumption.

Let’s check our learning outcomes!

1. **Which of the following statements most accurately describes the One Health approach to antimicrobial resistance?**
   a) It focuses solely on minimizing antibiotic use in human healthcare.
   b) It emphasizes the connection between human, animal, and environmental health in managing AMR.
   c) It applies only to livestock and companion animals.
   d) It prioritizes reducing antibiotic usage in all sectors equally, without regard to specific needs.
2. **What is the primary role of antimicrobial stewardship in veterinary medicine?**
   a) To encourage the complete elimination of antibiotic use in animals.
   b) To minimize the development of resistance by ensuring responsible and targeted antibiotic use.
   c) To promote the use of broad-spectrum antibiotics for faster treatment.
   d) To increase the dosage of antibiotics for quicker recovery.
3. **Which of the following practices increases selective pressure for antimicrobial resistance in bacterial populations?**
   a) Using antibiotics solely under veterinary prescription.
   b) Administering antibiotics as part of metaphylactic treatment.
   c) Using sub-therapeutic doses for growth promotion.
   d) Rotating antibiotics frequently within treatment protocols.
4. **Which of the following is *not* a typical practice within an antimicrobial stewardship program?**
   a) Regular monitoring and assessment of antibiotic use patterns.
   b) Limiting the use of critically important antibiotics.
   c) Substituting antibiotics with probiotics in all cases.
   d) Emphasizing targeted therapies over empirical treatments.
5. **The term "withdrawal period" refers to:**
   a) The period required for full antibiotic efficacy in livestock.
   b) The time after antibiotic administration during which the animal’s products are unsafe for consumption.
   c) The minimum amount of time antibiotics should be used in animals.
   d) The time needed for animals to recover after an infection is treated.
6. **Which of the following mechanisms is responsible for *intrinsic* resistance in some bacterial species?**
   a) Efflux pumps actively removing antibiotics.
   b) Acquisition of resistance genes from other organisms.
   c) Plasmid-mediated transfer of resistance genes.
   d) Random mutations occurring in bacterial DNA.
7. **NDM-1 (New Delhi Metallo-Beta-Lactamase) is a resistance factor primarily associated with:**
   a) Resistance to beta-lactam antibiotics, including carbapenems.
   b) Increased sensitivity to carbapenem antibiotics.
   c) Resistance to fluoroquinolone antibiotics only.
   d) Susceptibility to penicillin.
8. **Which antibiotic class is typically excluded from use in human medicine, thus less likely to contribute to cross-species AMR issues?**
   a) Tetracyclines
   b) Macrolides
   c) Ionophores
   d) Cephalosporins

9. **Which approach is recommended to minimize the risk of AMR development when treating a large group of livestock?**
   a) Avoid any antibiotic use.
   b) Apply metaphylaxis only under veterinary guidance, using the narrowest effective spectrum.
   c) Use broad-spectrum antibiotics for preventive care.
   d) Apply antibiotics universally to reduce treatment time.
10. **Extra-Label Drug Use (ELDU) in veterinary medicine:**
    a) Is generally discouraged unless absolutely necessary.
    b) Is illegal under all circumstances.
    c) Allows veterinarians to use drugs in a manner not specified on the label, under regulated conditions.
    d) Is commonly used to speed up the elimination of disease regardless of guidelines.
11. **Cross-resistance in bacteria refers to:**
    a) Resistance to multiple drugs through similar mechanisms.
    b) Complete sensitivity to one drug despite resistance to others.
    c) The lack of resistance to any antibiotic.
    d) Resistance limited to a single antibiotic class only.
12. **In which situation is the prophylactic use of antibiotics most appropriate in farm animals?**
    a) As a growth promoter.
    b) For general disease prevention in all animals.
    c) When a high infection risk is present and veterinary oversight is available.
    d) For long-term prevention without regard to specific risks.
13. **In the context of antibiotic treatment, "narrow-spectrum" antibiotics:**
    a) Are typically ineffective against gram-negative bacteria.
    b) Target a limited range of bacteria, often used to avoid disturbing the microbiome.
    c) Are only used as last-resort antibiotics.
    d) Are broad-spectrum and often preferred for initial treatment.
14. **Multidrug-resistant (MDR) organisms are classified as such when they:**
    a) Show resistance to only one antibiotic.
    b) Are sensitive to all but one class of antibiotics.
    c) Are resistant to three or more classes of antibiotics.
    d) Exhibit complete resistance to all known antibiotics.
15. **In terms of AMR risk, the primary difference between intensive and organic farming is:**
    a) Organic farming eliminates all risk of antimicrobial resistance.
    b) Intensive farming inherently causes higher resistance.
    c) Both farming practices can develop resistance based on the level of antibiotic use.
    d) Organic farms only treat animals individually, avoiding AMR.

Answers:

1. b)	2. b)	3. c)	4. c)	5. b)	6. a)	7. a)	8. c)
9. b)	10. c)	11. a)	12. c)	13. b)	14. c)	15. c)	

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"It's not about using less antibiotics. It's about using the right antibiotic for the right diagnosis and for the right duration of time."
-Susan Bleasdale, Medical Director of Infection Prevention and Control at University of Iowa Health

If we use antibiotics when not needed, we may not have them when they are most needed."
-Tom Frieden, MD, Former Director U.S. CDC

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