# Table of Contents

Introduction ........................................................................................................ ii

Using Antibiograms in Veterinary Practice .................................................... 1

Anatomy of an Antibiogram

Simple Antibiogram ......................................................................................... 3
Detailed Antibiogram ....................................................................................... 4

How to Read an Antibiogram

Simple Antibiogram ......................................................................................... 5
Detailed Antibiogram ....................................................................................... 6
Introduction

Antibiograms represent cumulative antimicrobial susceptibility data for a particular bacterial organism and host species combination. They provide information about the proportion of bacterial isolates that are susceptible to the drugs tested. Antibiograms can be used by veterinarians as a clinical tool to target antibiotic therapy and assess trends in antibiotic resistance. Although widely used in human health systems, antibiograms are not often available in veterinary medicine, particularly for livestock species. The California Department of Food and Agriculture Antimicrobial Use and Stewardship program (CDFA AUS) and the UC Davis California Animal Health and Food Safety Laboratory (CAHFS) created this document to promote the use of antibiograms in large animal veterinary medicine.

Antibiograms are often specific to a certain region or populace, such as a human hospital. This allows for a more precise evaluation of antibiotic resistance profiles among the target population.

Antimicrobial resistance patterns can change over time and are influenced by factors such as geographic region, production type, and management practices. Therefore, antibiograms are most useful when they are up to date and specific to the population of interest.

CDFA AUS and CAHFS aim to educate veterinary clinicians on the use of antibiograms so they can be effectively used to direct empiric antibiotic selection, improve treatment outcomes, and assess antibiotic resistance prevalence and trends in California.
All client information is kept confidential at CAHFS. For more information on how CAHFS analyzes antibiotic susceptibility, please see: https://www.cdfa.ca.gov/AHFSS/aus/docs/AntibiogramDevelopment.pdf

It is vital for the creation of anti-biograms that clinical samples continue to be submitted to CAHFS for susceptibility testing. Anti-biograms are useful to guide initial empiric therapy but should not replace case-specific testing to determine a more definitive diagnosis for appropriate therapy. More targeted anti-biograms require detailed information on submission forms that include the age of the animal, production class, location, and previous treatments. For questions regarding sample submission, please contact CAHFS at (530) 752-8700.

| Sample |

To sign up for anti-biograms from CAHFS, please scan the QR code (pictured left) or use this link: http://tinyurl.com/AntibiogramSignup

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To fill out the form:
- **Veterinarian’s Name**
- **Owner Name**
- **Clinic Name**
- **Ranch**
- **Address**
- **City**
- **State**
- **Zip**
- **Phone**
- **Email**
- **Report to:**
- **Prefered reporting method:**
- **Email notification of sample receipt?**
- **Date sample(s) collected.**
- **Date sample(s) shipped.**
- **History** (clinical signs, nutrition, housing, vaccination, treatment, production level, etc. Use next page if more space is needed)
- **Duration of Illness:**
- **Date of death:**
- **Euthanized?**
- **Insured?**
- **Disease(s) or condition(s) suspected**
- **Animal/Specimen Identification**
- **Test(s) Requested**
- **Current Location of Animal(s)**
- **Production Class**
Using Antibiograms in Veterinary Practice

What is an antibiogram?
An antibiogram represents a summary of cumulative antimicrobial susceptibility test data for a given drug-bug-host combination over a specified time-period (e.g. one year) and population subset (e.g. region, farm, production-type, etc.).

How can I use an antibiogram?
DO use antibiograms to:
- Guide empiric therapy
- Assess local susceptibilities
- Monitor resistance trends

DO NOT use antibiograms to:
- Replace culture & sensitivity
- Extrapolate results to other regions
- Make decisions if the antibiogram is outdated

What data is used in CAHFS antibiograms?
Unless otherwise specified, CAHFS antibiograms will:
- Contain only isolates from animals with clinical disease associated with the bacterial organism tested.
- Be based on a minimum of 30 isolates.
- Be updated annually. If fewer than 30 isolates are available, the time between updates will be extended as needed.

According to the Clinical & Laboratory Standards Institute (CLSI), estimates of percent susceptibility have less statistical validity when there are fewer than 30 isolates. If needed, CAHFS will extend the timeframe of the antibiogram until there are 30 or more isolates available for inclusion.
What do these terms mean?

**Clinical breakpoint** – The minimum inhibitory concentration (MIC) used to categorize an organism as susceptible (S), intermediate (I), or resistant (R). The S/I/R categorization is derived from microbiological characteristics, pharmacokinetic/pharmacodynamic (PK/PD) parameters, and/or clinical outcome data. CAHFS utilizes breakpoints established by CLSI.

**Susceptible (S)** – The bacterial isolate is inhibited by a concentration of drug that is usually achievable at the site of infection.

**Intermediate (I)** – The bacterial isolate has an MIC that falls between the breakpoints for susceptible and resistant. Clinical efficacy might be achieved in body sites where the drug concentrates (e.g. urine).

**Resistant (R)** – The bacterial isolate is not inhibited by the concentrations of drug that are usually achievable at the site of infection.

**Non-susceptible** – The isolate is either resistant or not completely susceptible to one or more antibiotics.

**NA** – No interpretive criteria are available.

Where can I find more information?

**Clinical & Laboratory Standards Institute (CLSI) publications:**

| CLSI M39: Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data | CLSI VET09: Understanding Susceptibility Test Data as a Component of Antimicrobial Stewardship in Veterinary Settings |
| CLSI VET01/VET01S: Performance Standards for Antimicrobial Disk and Dilution Susceptibility Tests for Bacteria Isolated From Animals | CLSI VET08: Performance Standards for Antimicrobial Disk and Dilution Susceptibility Tests for Bacteria Isolated From Animals |

**Link to MIC/Antibiogram Process Visual:**
[https://www.cdfa.ca.gov/AHFSS/aus/docs/AntibiogramDevelopment.pdf](https://www.cdfa.ca.gov/AHFSS/aus/docs/AntibiogramDevelopment.pdf)
## Anatomy of a Simple Antibiogram

### Antimicrobial agents tested
This is usually determined based on the animal host and microbial organism (drug names removed for this example).

### Title
Identifies the host species, organism profile and timeframe for the antibiogram.

### Example Table

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Organism X (n=83)</th>
<th>Organism Y (n=90)</th>
<th>Organism Z (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 1a</td>
<td>49%</td>
<td>94%</td>
<td>See below&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Drug 1b</td>
<td></td>
<td></td>
<td>96%</td>
</tr>
<tr>
<td><strong>Class 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 2a&lt;sup&gt;c&lt;/sup&gt;</td>
<td>99%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Class 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 3a&lt;sup&gt;c&lt;/sup&gt;</td>
<td>41%</td>
<td>47%</td>
<td>98%</td>
</tr>
<tr>
<td>Drug 3b</td>
<td>41%</td>
<td>49%</td>
<td>98%</td>
</tr>
</tbody>
</table>

<sup>a</sup> S (Susceptible) based on the Clinical Laboratory Standards Institute (CLSI) cattle-specific breakpoints for each drug/bug combination.

<sup>b</sup> New criteria indicates this isolate is susceptible to Drug 1a (if MIC less than 0.06) which current methods cannot evaluate.

<sup>c</sup> No CLSI breakpoint for Organism Z in cattle, extrapolated from Organism X CLSI breakpoints.

### Important notes and disclaimers
About the data presented; may include disclaimer if breakpoints from other host species or organisms are used or notes about extra-label drug use.

### Percentage of total isolates susceptible
To the drug.
Anatomy of a Detailed Antibiogram

**Antimicrobial agents tested:** this is usually determined by the animal host and microbial organism tested (drug names removed for this example)

**Breakpoints:** minimum inhibitory concentrations of the drug at which the microbial organism is classified as susceptible, intermediate, or resistant

**Title:** identifies the bacterial organism, animal host and timeframe for the antibiogram (drug names removed for this example)

**Shaded areas in table indicate the range of concentrations tested for each drug**

**Organism X** Respiratory Sites Cattle CAHFS Clinical Isolates July 1, 2019 - June 30, 2020

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Susceptible</th>
<th>Intermediate</th>
<th>Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 1a</td>
<td>≤0.03</td>
<td>0.06-0.12</td>
<td>≥0.25</td>
</tr>
<tr>
<td>Drug 1b</td>
<td>≤0.25</td>
<td>0.5</td>
<td>≥1</td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 2a</td>
<td>≤2</td>
<td>4</td>
<td>≥8</td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 3a</td>
<td>≤0.25</td>
<td>0.5</td>
<td>≥1</td>
</tr>
<tr>
<td>Drug 3b</td>
<td>≤0.25</td>
<td>0.5-1.0</td>
<td>≥2</td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 4a</td>
<td>≤8</td>
<td>16</td>
<td>≥32</td>
</tr>
<tr>
<td>Drug 4b</td>
<td>≤4</td>
<td>8</td>
<td>≥16</td>
</tr>
</tbody>
</table>

**Breakpoints:**
- Susceptible: ≤ MIC breakpoint
- Intermediate: MIC breakpoint < Concentration < MIC breakpoint
- Resistant: ≥ MIC breakpoint

**Breakpoints** for respiratory sites: CLSI Cattle Organism X breakpoints for respiratory sites.

**Key:**
- Susceptible (S)
- Intermediate (I)
- Resistant (R)

**Percentage of total microbial isolates classified as susceptible to the drug**

<table>
<thead>
<tr>
<th>MIC greater than highest concentration tested (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
</tr>
</tbody>
</table>

**Important notes and disclaimers**
- about the data presented; may include disclaimer if breakpoints from a different host species or organism are used, explanation of color shading and notes about extra-label drug use

**Numbers in **bold** to the right of shaded area have an MIC > than highest concentration tested.**

- New criteria indicates this isolate is susceptible to Drug 1a if MIC less than 0.06 which current methods cannot evaluate.

**CDFA - Antimicrobial Use and Stewardship | www.cdfa.ca.gov/ahfss/aus**
# How to Read a Simple Antibiogram

<table>
<thead>
<tr>
<th>CAHFS Bovine Respiratory Pathogens Antibiogram July 2019 - June 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organism X (n=83)</strong></td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td><strong>Antimicrobial</strong></td>
</tr>
<tr>
<td><strong>Class 1</strong></td>
</tr>
<tr>
<td>Drug 1a</td>
</tr>
<tr>
<td>Drug 1b</td>
</tr>
<tr>
<td><strong>Class 2</strong></td>
</tr>
<tr>
<td>Drug 2a</td>
</tr>
<tr>
<td><strong>Class 3</strong></td>
</tr>
<tr>
<td>Drug 3a</td>
</tr>
<tr>
<td>Drug 3b</td>
</tr>
</tbody>
</table>

*S (Susceptible) based on the Clinical Laboratory Standards Institute (CLSI) cattle-specific breakpoints for each drug/bug combination.

* New criteria indicates this isolate is susceptible to Drug 1a (if MIC less than 0.06) which current methods cannot evaluate.

* No CLSI breakpoint for Organism Z in cattle, extrapolated from Organism X CLSI breakpoints.

The higher the percentage susceptible, the greater the chance of treatment success.

If you are unsure which organism is causing the disease, you should pick an antibiotic with a high percentage of susceptible isolates for all possible organisms. In this example, Drug 2a should be chosen over Drug 3a.

Percentage of microbial isolates tested of each organism that were susceptible to this antibiotic.
How to Read a Detailed Antibiogram

### Organism X Respiratory Sites Cattle CAHFS Clinical Isolates July 1, 2019 - June 30, 2020

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Concentration (ug/mL)</th>
<th>N=83</th>
<th>% Susceptible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.12</td>
<td>0.25</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Class 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 1a</td>
<td>≤0.03</td>
<td>0.06-0.12</td>
<td>≥0.25</td>
</tr>
<tr>
<td>Drug 1b</td>
<td>≤0.25</td>
<td>0.5</td>
<td>≥1</td>
</tr>
<tr>
<td><strong>Class 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 2a</td>
<td>≤2</td>
<td>4</td>
<td>≥8</td>
</tr>
<tr>
<td>Drug 3a</td>
<td>≤0.25</td>
<td>0.5</td>
<td>≥1</td>
</tr>
<tr>
<td>Drug 3b</td>
<td>≤0.25</td>
<td>0.5-1.0</td>
<td>≥2</td>
</tr>
<tr>
<td><strong>Class 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug 4a</td>
<td>≤8</td>
<td>16</td>
<td>≥32</td>
</tr>
<tr>
<td>Drug 4b</td>
<td>≤4</td>
<td>8</td>
<td>≥16</td>
</tr>
</tbody>
</table>

*The numbers of susceptible (yellow), intermediate (gold) and resistant (brown) isolates are shown for each antimicrobial. Solid bold line marks breakpoint for resistance.
Numbers in bold to the right of shaded area have an MIC > than highest concentration tested.

**CLSI Cattle Organism X breakpoints for respiratory sites.**

**New criteria indicates this isolate is susceptible to Drug 1a (IF MIC less than 0.06) which current methods cannot evaluate.**

---

**Percentage of isolates classified as intermediate (I)**

**Clinical efficacy might be achieved in body sites where the drug concentrates**

**Percentage of isolates classified as susceptible (S)**

**Percentage of isolates classified as resistant (R)**

**Breakpoint for classification of resistance**

**Percentage of isolates with an MIC greater than the highest concentration tested** (also classified as resistant)

**Percentage of isolates classified as susceptible to this antibiotic**

The higher percentage susceptible, the greater the chance of treatment success using the specified drug.
Get Involved

Californian veterinarians have options to expand their knowledge:

• Request additional information on antibiograms
• Plan a continuing education seminar for your local veterinary medical association or practice
• Provide feedback or request a particular species, production type or pathogen-focused antibiogram

Please continue to submit samples with complete submission forms for culture and antibiotic susceptibility testing so CAHFS can create robust livestock antibiograms!

To sign up for antibiograms from CAHFS, please scan the QR code (pictured left) or use this link: http://tinyurl.com/AntibiogramSignup

For requests or questions regarding California-focused livestock antibiograms, please contact CDFA AUS at: CDFA_AUS@CDFA.CA.GOV