WORKBOOK

Instructions for Use of 2023 BIT Part F

CLSI Version 1.0. This was last updated on 15 May 2023 and has been approved by CLSI's Outreach Working Group.
This is Part E of the of the 2023 Breakpoint Implementation Toolkit.
To access the entire BIT Toolkit, visit https://clsi.org/bit-toolkit/.

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Accuracy Instructions for Prefilled Excel

Workbook Overview

1. This workbook contains Microsoft Excel VBA Macros.
2. This workbook can be used to summarize and determine the performance of a test generating minimum inhibitory concentration (MIC) values (eg, broth microdilution panel, MIC card, or gradient diffusion strips) using specific CDC and FDA Antimicrobial Resistance Isolate Bank (AR Bank) Breakpoint Implementation Toolkit (BIT) isolate sets.
3. This workbook contains multiple worksheets that are stratified by AR Bank BIT sets specifically curated to validate updated CLSI breakpoints for specific antimicrobials (Table 1). Each worksheet is prefilled with the list of curated isolates and their AR Bank minimal inhibitory concentration (MIC) values and interpretations.
   a. BIT-1 (AR Bank panel name: BIT): Enterobacterales for ertapenem, meropenem, imipenem, cefazolin, aztreonam, cefepime, ceftazidime, cefotaxime, ceftriaxone, ciprofloxacin, or levofloxacin.
   b. BIT-2 (AR Bank panel name: PTA): Enterobacterales for piperacillin/tazobactam, gentamicin, tobramycin, amikacin, or colistin.
   c. BIT-3 (AR Bank panel name: PFA): Pseudomonas aeruginosa for meropenem, imipenem, aztreonam, cefepime, ceftazidime, piperacillin/tazobactam, tobramycin, ciprofloxacin, levofloxacin, or colistin.
   d. BIT-4 (AR Bank panel name: ACI): Acinetobacter spp. for meropenem, imipenem, or colistin.

   NOTE: Within each BIT worksheet, the specific antimicrobials are independent of each other. This means the user has the choice to validate or verify some, but not all, antimicrobials.

Table 1. Summary of Organism and Breakpoints Included in the Breakpoint Implementation Toolkit

Antimicrobial	Reporting Group	2023 CLSI Breakpoint (S/I or SDD/R)	BIT Set
Amikacin	Enterobacterales	4/8/16	BIT-2
Aztreonam	Enterobacterales	4/8/16	BIT-1
	Pseudomonas aeruginosa	8/16/32	BIT-3
Cefazolin	Enterobacterales	2/4/8	BIT-1
Cefepime	Enterobacterales	2/4-8/16	BIT-1
	Pseudomonas aeruginosa	8/16/32	BIT-3
Cefotaxime	Enterobacterales	1/2/4	BIT-1
Ceftazidime	Enterobacterales	4/8/16	BIT-1
	Pseudomonas aeruginosa	8/16/32	BIT-3
Ceftriaxone	Enterobacterales	1/2/4	BIT-1
Colistin	Enterobacterales	2/4	BIT-2
	Pseudomonas aeruginosa	2/4	BIT-3
	Acinetobacter baumannii	2/4	BIT-4
Ciprofloxacin	Enterobacterales	0.25/0.5/1	BIT-1
	Pseudomonas aeruginosa	0.5/1/2	BIT-3
Ertapenem	Enterobacterales	0.5/1/2	BIT-1
Gentamicin	Enterobacterales	2/4/8	BIT-2
Imipenem	Enterobacterales	1/2/4	BIT-1
	Pseudomonas aeruginosa	2/4/8	BIT-3
	Acinetobacter baumannii	2/4/8	BIT-4
Levofloxacin	Enterobacterales	0.5/1/2	BIT-1
	Pseudomonas aeruginosa	1/2/4	BIT-3
Meropenem	Enterobacterales	1/2/4	BIT-1
	Pseudomonas aeruginosa	2/4/8	BIT-3
	Acinetobacter baumannii	2/4/8	BIT-4
Piperacillin/tazobactam	Enterobacterales	8/16/32	BIT-2
	Pseudomonas aeruginosa	16/32/64	BIT-3
Tobramycin	Enterobacterales	2/4/8	BIT-2
	Pseudomonas aeruginosa	1/2/4	BIT-3

Abbreviations: BIT, breakpoint implementation toolkit; I, intermediate; R, resistant; S, susceptible.

4. For each BIT set, 5 isolates have been suggested for reproducibility/precision testing. Within each BIT set tab, these recommended isolates are highlighted in green. These isolates are recommendations; the laboratory may decide to use other strains, including QC organisms. At minimum to evaluate precision; 3 isolates should be included for each antimicrobial agent.
5. Data are only entered in cells that are shaded orange (see below for detailed instructions). Other cells contain formulas that depend upon data entered and must not be modified. There are also hidden cells that perform modifications and/or calculations to the data that are necessary for proper evaluation.
6. The worksheets are protected for the user's benefit. However, if a user would like to view hidden columns and/or view/edit formulas, the worksheets can be unprotected without a password.
7. Users should not copy and paste data from external sources to this spreadsheet, doing so invalidates data validation rules set to certain cells. Mathematical calculations in hidden cells depend upon proper data format (ie, all numeric values for MICs).
8. The Summary tab will display aggregate accuracy performance from each completed study by antimicrobial and reporting group. If multiple reporting groups were tested for a single antimicrobial, the combined overall accuracy is displayed.

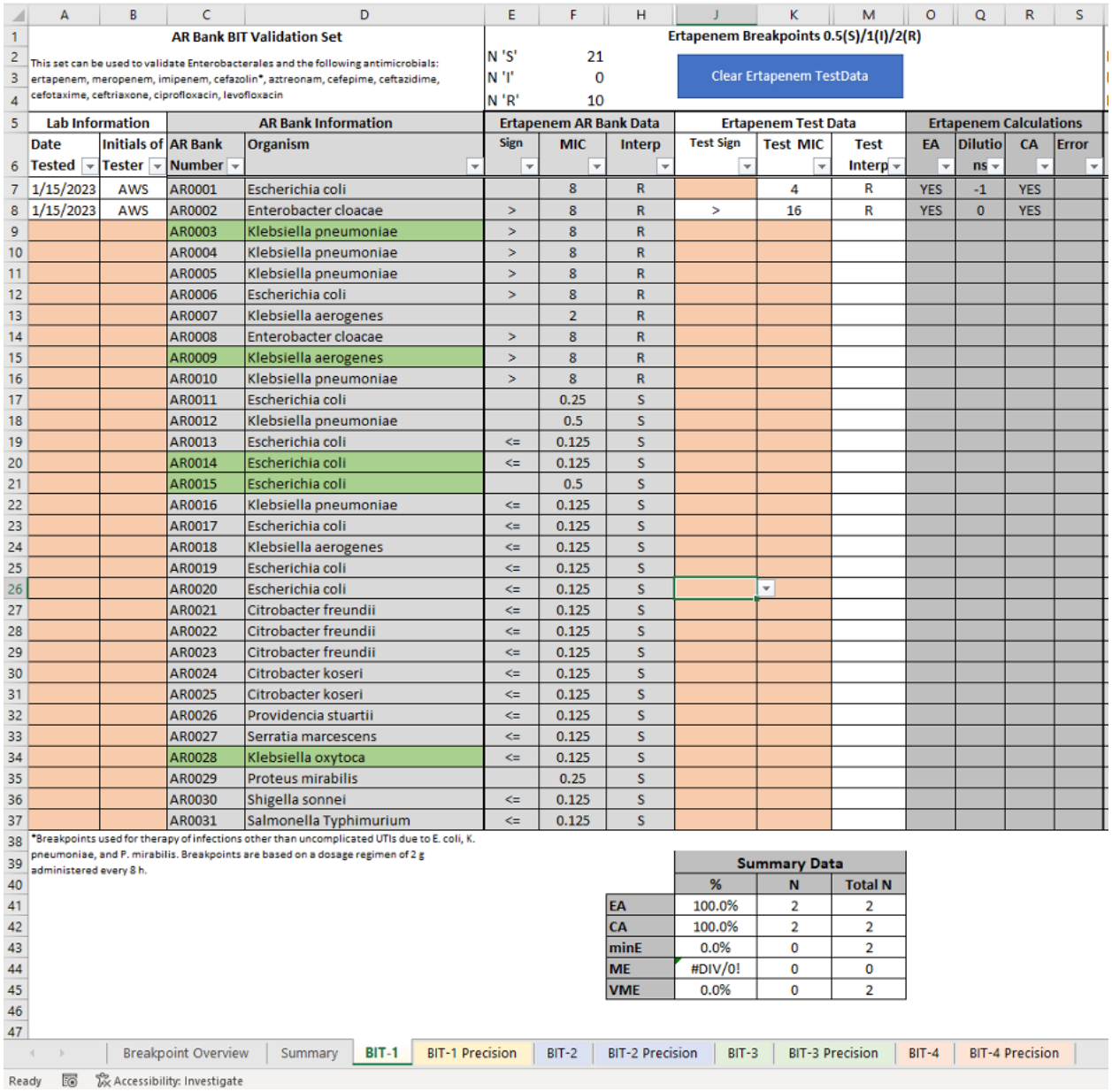
WARNING: Any manipulation beyond the instructions provided here may invalidate formulas and lead to erroneous results.

Accuracy

Accuracy is defined as the closeness of agreement between a measured quantity value and a true quantity value of a measurand (AR Bank MIC). For AST, accuracy is the agreement of the test system result with the result generated for the same isolate with the appropriate reference method. To establish the performance characteristics of a test system, a minimum of 30 isolates should be tested. If a laboratory were verifying the performance characteristics established by the manufacturer, the lab may choose to test fewer isolates. Final results should be used if discrepancy testing was performed.

Using the Excel for Accuracy

1. Find the appropriate BIT tab and navigate horizontally to the specific antimicrobial being validated. This area is indicated by a header describing drug name and CLSI breakpoints being validated. Ertapenem is shown below.



AR Bank BIT Validation Set

This set can be used to validate Enterobacterales and the following antimicrobials: ertapenem, meropenem, imipenem, cefazolin*, aztreonam, cefepime, ceftazidime, cefotaxime, ceftriaxone, ciprofloxacin, levofloxacin

Ertapenem Breakpoints 0.5(S)/1(I)/2(R)

N 'S' 21
N 'I' 0
N 'R' 10

Clear Ertapenem TestData

Lab Information		AR Bank Information		Ertapenem AR Bank Data			Ertapenem Test Data			Ertapenem Calculations			
Date Tested	Initials of Tester	AR Bank Number	Organism	Sign	MIC	Interp	Test Sign	Test MIC	Test Interp	EA	Dilutions	CA	Error
1/15/2023	AWS	AR0001	Escherichia coli		8	R		4	R	YES	-1	YES	
1/15/2023	AWS	AR0002	Enterobacter cloacae	>	8	R	>	16	R	YES	0	YES	
		AR0003	Klebsiella pneumoniae	>	8	R							
		AR0004	Klebsiella pneumoniae	>	8	R							
		AR0005	Klebsiella pneumoniae	>	8	R							
		AR0006	Escherichia coli	>	8	R							
		AR0007	Klebsiella aerogenes		2	R							
		AR0008	Enterobacter cloacae	>	8	R							
		AR0009	Klebsiella aerogenes	>	8	R							
		AR0010	Klebsiella pneumoniae	>	8	R							
		AR0011	Escherichia coli		0.25	S							
		AR0012	Klebsiella pneumoniae		0.5	S							
		AR0013	Escherichia coli	<=	0.125	S							
		AR0014	Escherichia coli	<=	0.125	S							
		AR0015	Escherichia coli		0.5	S							
		AR0016	Klebsiella pneumoniae	<=	0.125	S							
		AR0017	Escherichia coli	<=	0.125	S							
		AR0018	Klebsiella aerogenes	<=	0.125	S							
		AR0019	Escherichia coli	<=	0.125	S							
		AR0020	Escherichia coli	<=	0.125	S							
		AR0021	Citrobacter freundii	<=	0.125	S							
		AR0022	Citrobacter freundii	<=	0.125	S							
		AR0023	Citrobacter freundii	<=	0.125	S							
		AR0024	Citrobacter koseri	<=	0.125	S							
		AR0025	Citrobacter koseri	<=	0.125	S							
		AR0026	Providencia stuartii	<=	0.125	S							
		AR0027	Serratia marcescens	<=	0.125	S							
		AR0028	Klebsiella oxytoca	<=	0.125	S							
		AR0029	Proteus mirabilis		0.25	S							
		AR0030	Shigella sonnei	<=	0.125	S							
		AR0031	Salmonella Typhimurium	<=	0.125	S							

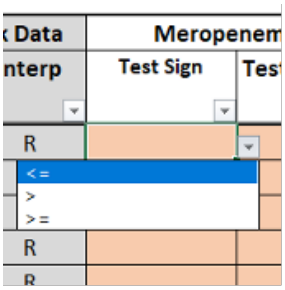
*Breakpoints used for therapy of infections other than uncomplicated UTIs due to E. coli, K. pneumoniae, and P. mirabilis. Breakpoints are based on a dosage regimen of 2 g administered every 8 h.

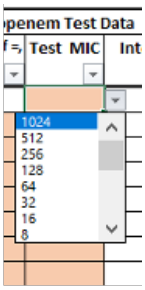
Summary Data			
	%	N	Total N
EA	100.0%	2	2
CA	100.0%	2	2
minE	0.0%	0	2
ME	#DIV/0!	0	0
VME	0.0%	0	2

Breakpoint Overview | Summary | BIT-1 | BIT-1 Precision | BIT-2 | BIT-2 Precision | BIT-3 | BIT-3 Precision | BIT-4 | BIT-4 Precision

Ready Accessibility: Investigate

2. Only cells that are orange are editable. For test data, only an MIC result is needed; the interpretation is automatically generated based on the MIC entered.
3. For each isolate, enter the results (MIC and sign associated with MICs for off-scale values) obtained from the test system/method being evaluated in the **[Insert Antimicrobial] Test Data** columns. The signs "<=" is used in place of "≤", and "≥ " is used in place of "≥". Data validation rules exist for both the **Test Sign** and **Test MIC** columns. Users may use the dropdown function (see below) or type in the character or values. If users type in a character or value not in the list, the entry will be rejected.

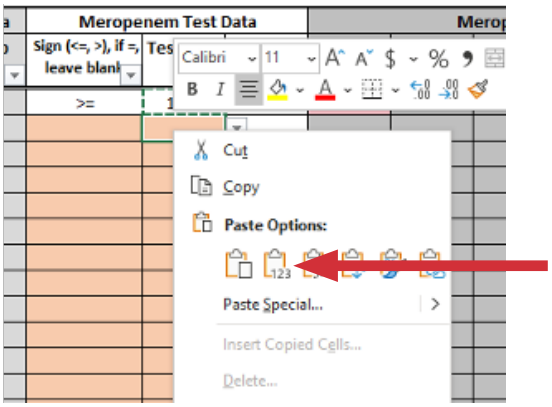




   a. Enter the numerical MIC value in the **Test MIC** column.
      i. When testing a combination agent (eg, piperacillin/tazobactam), only enter the value for the first component (eg, piperacillin).
      ii. When entering data generated by gradient diffusion strips, round up any "in-between" MIC values to the next higher $\log_2$ dilution (eg, 1.5 is rounded up to 2).
      iii. For lower MICs, the actual concentration should be used (ie, enter 0.12 as 0.125, 0.06 as 0.063, 0.03 as 0.031...). **NOTE:** This is specific to this workbook and not related to reporting of MICs. This format is necessary to accurately calculate essential agreement after the MIC conversion to inverse of logarithmic base 2 function: $\log_2(\text{MIC})=x$, where $2^x=\text{MIC}$.
   b. For MIC results that are on-scale (eg, =8), leave **Test Sign** column blank. See AR Bank isolate #1 below.
   c. For MIC results that are off-scale, enter the appropriate sign in the **Test Sign** column (eg, if the result is >16, enter or select ">"). See AR Bank isolate # 2 below.

C	D	E	F	H	J	K	M	O	Q	R	S
AR Bank BIT Validation Set					**Ertapenem Breakpoints 0.5(S)/1(I)/2(R)**						
idate Enterobacterales and the following antimicrobials: imipenem, cefazolin*, aztreonam, cefepime, ceftazidime, iprofloxacin, levofloxacin		N 'S'	21		Clear Ertapenem TestData						
		N 'I'	0								
		N 'R'	10								
	AR Bank Information		**Ertapenem AR Bank Data**		**Ertapenem Test Data**			**Ertapenem Calculations**			
f	**AR Bank Number**	**Organism**	**Sign**	**MIC**	**Interp**	**Test Sign**	**Test MIC**	**Test Interp**	**EA**	**Dilutions**	**CA**	**Error**
	AR0001	Escherichia coli		8	R		4	R	YES	-1	YES	
	AR0002	Enterobacter cloacae	>	8	R	>	16	R	YES	0	YES	
	AR0003	Klebsiella pneumoniae	>	8	R							

   d. There is no need to calculate the categorical interpretation. The interpretation is automatically generated based upon the MIC entered.



WARNINGS: Do not use default copy/paste function or drag data from another excel worksheet or cell. This action will replace existing data validation rules with validation rules from the source and may invalidate formulas, leading to erroneous calculations. Copy and paste function may be used if using the Paste Values under Paste Options. Proceed as follows: select the range of cells to copy data into and right click; select the arrow at Paste Special; select the first option under Paste Values.

Do not copy/paste or drag data from one cell to another in the same worksheet across worksheets. This action may lead to changes in cell reference that are precedents to certain calculations in hidden columns and can lead to erroneous calculations.

Clearing Test Data

If Macros are disabled: Highlight the test data cells to be cleared (**Test Sign** and/or **Test MIC**), right click and select "Clear Contents." This may need to be done in chunks or using the CTRL key.

If Macros are enabled: Click the blue **"Clear [Insert Antimicrobial Name] TestData"** button (indicated by the arrow below) and confirm you want to proceed with deleting test results. This will clear the **Test Sign** and **Test MIC** columns. Each antimicrobial agent has a specific clear button.

	A	B	C	D	F	H	I	K	M	O	P	Q
1	**AR Bank BIT Validation Set**					**Ertapenem Breakpoints 0.5(S)/1(I)/2(R)**						
2	This set can be used to validate Enterobacterales and the		N 'S'	21								
3	following antimicrobials: ertapenem, meropenem, imipenem,		N 'I'	0		Clear Ertapenem TestData						
4	cefazolin*, aztreonam, cefepime, ceftazidime, cefotaxime, ceftriaxone, ciprofloxacin, levofloxacin		N 'R'	10								
5	**AR Bank/Comparator Info**		**Ertapenem AR Bank Data**			**Ertapenem Test Data**			**Ertapenem Calculations**			
6	**AR Bank Number**	**Organism**	**Sign**	**MIC**	**Interp**	**Test Sign**	**Test MIC**	**Test Interp**	**EA**	**Dilutions**	**CA**	**Error**
7	1	Escherichia coli		8	R		4	R	YES	-1	YES	
8	2	Enterobacter cloacae	>	8	R	>	16	R	YES	0	YES	
9	3	Klebsiella pneumoniae	>	8	R							
10	4	Klebsiella pneumoniae	>	8	R							

NOTE: The use of Macros clears the Excel "undo stack". This means you can no longer undo (CTRL+Z) to the previous step or action. Saving the file prior to use on a cloud-based file system with version control is recommended. This allows recovery of previous versions of the workbook if data is accidentally cleared by the macro.

Analysis Within the BIT Set Worksheets

As test data are entered, analysis of the results will ensue under the "Calculations" section. This area is read-only and cannot be edited. These columns compare the **Test MICs** and categorical interpretation (**Test Interp**) from the test system to the AR Bank **MIC** and categorical interpretation results (**Interp**).

Essential Agreement (EA): MIC result obtained with the AST system that is within one doubling dilution step from the AR Bank MIC value. Calculations are scaled and adjusted for off-scale results (ie, >32 and >64 are within EA; >32 and 32 are within EA; >32 and 16 are not within EA). If the **Test MIC** of the isolate is in essential agreement with the AR Bank **MIC**, the field will display **YES**; if the results are not in essential agreement, the field will display **NO** and be highlighted red. The overall EA is expressed as a percentage of those data points within EA divided by the total number of isolates tested.

Dilutions: This is the calculated number of $\log_2$ dilutions the **Test MIC** deviates from the AR Bank **MIC**. This is scaled to the most conservative MIC and adjusted for off-scale results (ie, >32 and >8= 0[exact]; >32 and 32 = -1; >32 and >=32 = 0). This column can be used to assess overall bias of results.

Category Agreement (CA): The agreement of interpretation (eg, susceptible, intermediate, susceptible-dose dependent, nonsusceptible, and resistant) results between the test and the interpretation of the AR Bank MIC result. If the **Test Interp** of the isolate is in agreement with the AR Bank Interp, the field will display **YES**; if the results are not in categorical agreement, the field will display **NO** and be highlighted red.

The overall CA is expressed as a percentage of those data points within CA divided by the total number of isolates tested.

Errors: The type of error (minor, major, very major) if CA is not obtained.

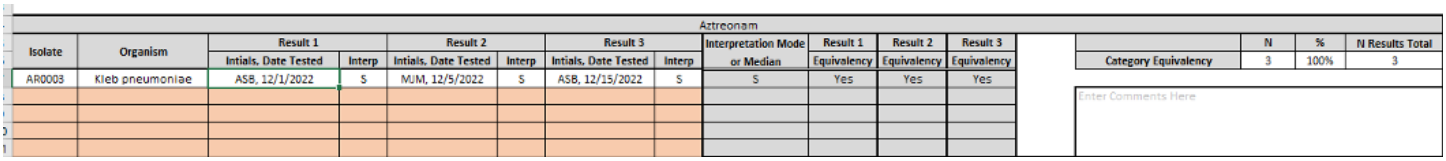
- **Minor Error (minE):** Difference in **Test Interp** and AR Bank **Interp** where one result is intermediate (I) (or susceptible-dose dependent [SDD]) and the other is susceptible or resistant. The overall minor error frequency is expressed as a percentage of those data points having a minor error divided by the total number of isolates tested.
- **Major Error (ME):** Error when the AR Bank **Interp** is susceptible and the **Test Interp** is resistant. The overall major error frequency is expressed as a percentage of those data points having a major error divided by the total number of susceptible AR Bank isolates tested.
- **Very Major Error (VME):** Error when the AR Bank **Interp** is resistant and the **Test Interp** is susceptible. The overall very major error frequency is expressed as a percentage of those data points having a very major error divided by the total number of resistant AR Bank isolates tested.

Precision/Reproducibility

Each AR Bank BIT set includes a corresponding Precision tab. Precision (or reproducibility) is defined as closeness of agreement between the results of successive measurements of the same analyte. Up to five isolates may be tested three separate times (separate inoculum preparations) to characterize the precision of the test system. These isolates may include a combination of AR Bank isolates and quality control strains (eg, ATCC strains).

Using the Excel for Precision (Reproducibility)

1. Navigate to the appropriate precision tab and antimicrobial section. Each BIT set has a corresponding precision tab. Within the tab, each drug has a separate table for calculating precision. The aztreonam table is shown below. Like the accuracy tabs, cells that are orange are editable.



Aztreonam															
Isolate	Organism	Result 1		Result 2		Result 3		Interpretation Mode or Median	Result 1 Equivalency	Result 2 Equivalency	Result 3 Equivalency		N	%	N Results Total
		Intials, Date Tested	Interp	Intials, Date Tested	Interp	Intials, Date Tested	Interp					Category Equivalency	3	100%	3
AR0003	Kleb pneumoniae	ASB, 12/1/2022	S	MJM, 12/5/2022	S	ASB, 12/15/2022	S	S	Yes	Yes	Yes				
												Enter Comments Here			

2. Enter the Isolate ID and organism.
3. For each isolate, enter the categorical result for each replicate (Result 1, Result 2, Result 3) and the date and initials of the tester.
4. Once the precision data is entered for each isolate, calculations will proceed in gray columns of the table. The most commonly occurring (mode) category is calculated. If no mode exists, then middle interpretation (or "median") is used in the rank of S, I or SDD, R.
   a. If R, R, and I replicate categorical results were obtained for an isolate, the "R" interpretation is considered the mode.
   b. If S, I, R replicate categorical results were obtained for an isolate, the "I" interpretation is considered the middle.
5. Each result is compared to the modal or middle categorical interpretation. The results are considered equivalent if the interpretation of the test result and modal or middle interpretation are the same.
6. The overall category equivalency is calculated as the number of equivalent data points divided by the total number of data points.

Reviewing Aggregated Summary Data

Data are gathered from each tab and antimicrobial/organism validation or verification study to a summary table. The table can display the studies' characteristics (such as number of total isolates tested, number of susceptible and resistant strains) and overall descriptive statistical calculations. The hyperlinks will navigate back to the corresponding antimicrobial's accuracy tab within the BIT worksheet.

General

	A	B	C	D	E	F	I	K	M	O	Q	R	S	T
1							Accuracy: Agreement and Errors					Precision/Reproducibility		
2	Set	Reporting Group	Antimicrobial	N	N 'S'	N 'R'	% CA	Errors				N	% Equivalent	N Equivalent
3								%Minor	%Major	% Very Major				
4	BIT-1	Enterobacterales	Aztreonam	0	0	0						0		0
5	BIT-1	Enterobacterales	Cefazolin	0	0	0						0		0
6	BIT-1	Enterobacterales	Cefepime	0	0	0						0		0
7	BIT-1	Enterobacterales	Cefotaxime	0	0	0						0		0
8	BIT-1	Enterobacterales	Ceftazidime	0	0	0						0		0
9	BIT-1	Enterobacterales	Ceftriaxone	0	0	0						0		0
10	BIT-1	Enterobacterales	Ciprofloxacin	0	0	0						0		0
11	BIT-1	Enterobacterales	Ertapenem	0	0	0						0		0
12	BIT-1	Enterobacterales	Imipenem	0	0	0						0		0
13	BIT-1	Enterobacterales	Levofloxacin	0	0	0						0		0
14	BIT-1	Enterobacterales	Meropenem	31	22	6	90.3%	9.7%	0.0%	0.0%		15	100%	15
15	BIT-2	Enterobacterales	Amikacin	0	0	0						0		0
16	BIT-2	Enterobacterales	Gentamicin	0	0	0						0		0
17	BIT-2	Enterobacterales	Piperacillin/tazobactam	0	0	0						0		0
18	BIT-2	Enterobacterales	Tobramycin	0	0	0						0		0
19	BIT-3	*Pseudomonas aeruginosa*	Aztreonam	0	0	0						0		0
20	BIT-3	*Pseudomonas aeruginosa*	Cefepime	0	0	0						0		0
21	BIT-3	*Pseudomonas aeruginosa*	Ceftazidime	0	0	0						0		0
22	BIT-3	*Pseudomonas aeruginosa*	Ciprofloxacin	0	0	0						0		0
23	BIT-3	*Pseudomonas aeruginosa*	Imipenem	0	0	0						0		0
24	BIT-3	*Pseudomonas aeruginosa*	Levofloxacin	0	0	0						0		0
25	BIT-3	*Pseudomonas aeruginosa*	Meropenem	30	11	15	86.7%	13.3%	0.0%	0.0%		15	100%	15
26	BIT-3	*Pseudomonas aeruginosa*	Piperacillin/tazobactam	0	0	0						0		0
27	BIT-3	*Pseudomonas aeruginosa*	Tobramycin	0	0	0						0		0
28	BIT-4	*Acinetobacter baumannii*	Imipenem	0	0	0						0		0
29	BIT-4	*Acinetobacter baumannii*	Meropenem	30	0	28	93.3%	6.7%	#DIV/0!	0.0%		15	100%	15
30	**NA**	**Combined**	**Aztreonam**	**0**	**0**	**0**						**0**		**0**
31	**NA**	**Combined**	**Cefepime**	**0**	**0**	**0**						**0**		**0**
32	**NA**	**Combined**	**Ceftazidime**	**0**	**0**	**0**						**0**		**0**
33	**NA**	**Combined**	**Ciprofloxacin**	**0**	**0**	**0**						**0**		**0**
34	**NA**	**Combined**	**Imipenem**	**0**	**0**	**0**						**0**		**0**
35	**NA**	**Combined**	**Levofloxacin**	**0**	**0**	**0**						**0**		**0**
36	**NA**	**Combined**	**Meropenem**	**91**	**33**	**49**	**90.1%**	**9.9%**	**0.0%**	**0.0%**		**45**	**100%**	**45**
37	**NA**	**Combined**	**Piperacillin/tazobactam**	**0**	**0**	**0**						**0**		**0**

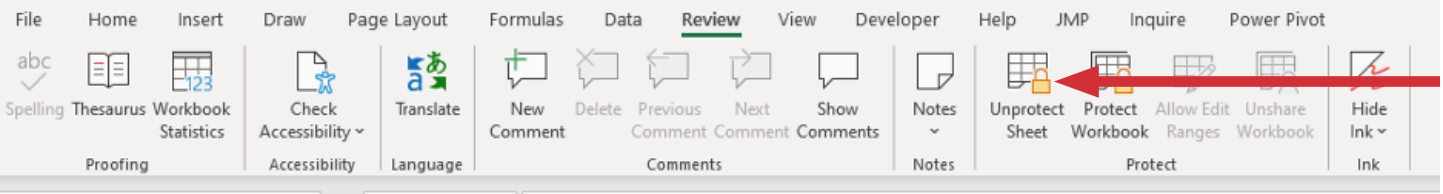
The table adds an additional element of aggregate data for combined reporting groups. The "Combined" under "Reporting Group" is calculated when multiple reporting groups are tested for a single antimicrobial. Overall calculations are performed combining all isolates for all reporting groups. See below for combined analysis of meropenem.

	A	B	C	D	E	F	I	K	M	O	Q	R	S	T
1							Accuracy: Agreement and Errors					Precision/Reproducibility		
2	Set	Reporting Group	Antimicrobial	N	N 'S'	N 'R'	% CA	Errors				N	% Equivalent	N Equivalent
3								%Minor	%Major	% Very Major				
29	BIT-1	Enterobacterales	Meropenem	31	22	6	90.3%	9.7%	0.0%	0.0%		15	100%	15
30	BIT-3	*Pseudomonas aeruginosa*	Meropenem	30	11	15	86.7%	13.3%	0.0%	0.0%		15	100%	15
31	BIT-4	*Acinetobacter baumannii*	Meropenem	30	0	28	93.3%	6.7%	#DIV/0!	0.0%		15	100%	15
32	**NA**	**Combined**	**Meropenem**	**91**	**33**	**49**	**90.1%**	**9.9%**	**0.0%**	**0.0%**		**45**	**100%**	**45**
33	BIT-2	Enterobacterales	Piperacillin/tazobactam	0	0	0						0		0
34	BIT-3	*Pseudomonas aeruginosa*	Piperacillin/tazobactam	0	0	0						0		0
35	**NA**	**Combined**	**Piperacillin/tazobactam**	**0**	**0**	**0**						**0**		**0**
36	BIT-2	Enterobacterales	Tobramycin	0	0	0						0		0
37	BIT-3	*Pseudomonas aeruginosa*	Tobramycin	0	0	0						0		0

NOTE: Essential agreement is not displayed, but can be unhidden, as breakpoint update validation and verification studies should focus assessment of performance on the ability to accurately assign the interpretation based on the new breakpoints.

Unlocking the Spreadsheet and Hidden Columns

Each sheet in the workbook is protected, except for the cells used for user data entry. This is done to prevent user error that may affect calculation cells (eg, misclicks). Users can unlock the sheets without a password as needed. To unlock the specific sheet, navigate to the Review ribbon in the menu bar, and click "Unprotect Sheet." There is no password needed. Any changes should be performed only by experienced Microsoft Excel users.



There are five hidden columns that perform intermediary calculations necessary to determine EA, number of Dilutions from the AR Bank MIC, CA, and Error type.

AR Bank Information		Ertapenem AR Bank Data					Ertapenem Test Data					Ertapenem Calculations				
AR Bank Number	Organism	Sign	MIC	Hidden MIC Result (conservative	Interp	Hidden MIC Result Logg	Test Sign	Test MIC	Hidden MIC Result (conservative	Test Interp	Hidden MIC Result Logge	EA	Hidden Ev	Dilutio n	CA	Error
AR0001	Escherichia coli		8	8	R	3										
AR0002	Enterobacter cloacae	>	8	16	R	4										
AR0003	Klebsiella pneumoniae	>	8	16	R	4										

The logic for the hidden columns is described below:

- **Hidden MIC Result Conservative (both AR Bank and Test Data areas)** - Incorporates the sign and calculates the most conservative MIC. This only affects MICs with greater than sign (>), which bumps the MIC to the next higher dilution. For devices that report a greater than or equal to sign (>=, ≥) or less than or equal to sign (<=, ≤), the most conservative MIC is the MIC reported with the sign. Examples of the conversions with and without the various signs are in the table below.
- **Hidden MIC Result Logged** - MIC conversion to inverse of logarithmic base 2 function: $\log_2(MIC)=x$, where $2^x=MIC$ This allows EA and dilution difference to be calculated. Examples of the logged conversions are below.

Reported MIC	Converted MIC Conservative Result	MIC Result Logged
16	16	4
> 16	32	5
>=16	16	4
0.5	0.5	-1
<=0.5	0.5	-1

- **Hidden Eval** - This variable indicates whether an MIC pair is evaluable with a "Yes" or "No" value. Evaluable is defined as when either reference or test MIC is on scale and that can be determined with certainty to be **at least** +1 or -1 dilution from each other along the combined scaled concentration range of MICs (it takes into account when MIC dilutions are not the same and scales it to the most conservative). This is an informational variable and not currently used in any calculations.