

November 15, 2002

Participant  
Centers for Disease Control and Prevention (CDC)  
Susceptibility Testing of *Mycobacterium tuberculosis* and Nontuberculous Mycobacteria Performance  
Evaluation Program

Subject: Analyses of Participant Laboratory Results for the June 2002 Shipment

Dear Participant:

Enclosed are analyses of laboratory test results reported to the Centers for Disease Control and Prevention (CDC) by participant laboratories for strains of *Mycobacterium tuberculosis*-complex and the nontuberculous mycobacteria (NTM), *M. xenopi*, shipped in June 2002. Participant laboratories received either four *M. tuberculosis* complex strains only or four *M. tuberculosis* strains and one NTM culture. Testing results were received and analyzed from 140 of 153 (92%) laboratories participating in this shipment.

The enclosed aggregate report is prepared in a format that will allow laboratories to compare their results with results obtained by other participants for the same strain using the same method, drug, and concentration. The first three pages contain descriptive information about the participant laboratories. We encourage you to circulate this report to personnel who are involved with drug susceptibility testing, reporting, or interpretation for *M. tuberculosis* and NTM.

The NTM strain in this performance evaluation is intended to provide an assessment of the various methods, drugs, and interpretations that are reported by laboratories that perform drug susceptibility testing for these different strains. The test results for the NTM strain also provides information on interlaboratory agreement with different test methods and will assist with efforts to develop standard methods for NTM drug susceptibility testing. By reporting these practices and test results, CDC is neither recommending nor endorsing these testing practices. Some of the test results reported by participants may, in fact, provide inappropriate or misleading information to the clinician. A consensus report by the American Thoracic Society and the National Committee for Clinical Laboratory Standards (NCCLS) tentative standard are referenced to provide participants with recommendations for NTM test methods and drugs that have clinical relevance.

If you have any comments or suggestions on the results in this report or have questions regarding the changes in this program, you may call me at (770) 488-8133.

Sincerely yours,

Bereneice M. Madison, Ph.D.  
Division of Laboratory Systems  
Public Health Practice Program Office

Enclosures

## **Analyses of the June 2002 Performance Evaluation Results for *M. tuberculosis* complex and Nontuberculous Mycobacteria Drug Susceptibility Testing Reported to the Centers for Disease Control and Prevention by Participating Laboratories**

This report is an analysis of laboratory test results reported to the Centers for Disease Control and Prevention (CDC) by participant laboratories for the four *Mycobacterium tuberculosis* complex and one *M. xenopi* strains shipped in June 2002. Participant laboratories received either four *M. tuberculosis* strains only or four *M. tuberculosis* and one NTM strain. Testing results were received and analyzed from 140 of 153 (92%) laboratories participating in this shipment. Of the laboratories that did not provide results, three had import permit or license issues; six laboratories had staff, laboratory construction, or culture media problems; and one laboratory no longer participates in the program.

### Descriptive Information on Participant laboratories

Figure 1 shows the laboratory classification reported by 140 of the participants. Participants consisted of 76 health departments, 46 hospitals, 12 independents, and 6 "other" type of laboratories.

Figure 2 provides the distribution of the annual volume of *M. tuberculosis* isolates tested for drug susceptibilities by participating laboratories in calendar year 2001.

Figure 3 lists the biosafety levels reported by participant laboratories for *M. tuberculosis*. All laboratories are strongly encouraged to consult the CDC/NIH manual, Biosafety in Microbiological and Biomedical Laboratories (4th edition) for recommendations and to determine their correct biosafety level.

Figure 4 provides a breakdown of the test procedures used by the participating laboratories for *M. tuberculosis* drug susceptibility testing. Participants were asked to check test methods used. Some methods, such as the proportion method with Lowenstein-Jensen (LJ) media, may reflect procedures used by international participants. The 'other' methods listed were BACTEC 960 (MGIT), microtiter, and LJ resistance ratio method.

Figure 5 provides information on the test procedures used by the participating laboratories testing *M. xenopi*.

### *M. tuberculosis* test results:

The aggregate test results are provided in separate tables, representing strains F, G, H, I and J to facilitate comparison among laboratories. Table 1 for the *M. tuberculosis* complex strains F, G, H, and I is constructed to include the results for the radiometric (BACTEC), agar proportion (AP), Lowenstein Jensen (LJ) proportion, and other methods at each concentration of drug. The test results are listed in the appropriate (susceptible or resistant) columns with a corresponding total number of tests (Sum) column provided as a denominator for determining the level of consensus. This report contains all results reported by participating laboratories, including many drug concentrations with only one result.

In Table 1 the concentrations recommended by CDC and the NCCLS for the primary (isoniazid, rifampin, pyrazinamide, and ethambutol) and secondary (streptomycin, ethionamide, kanamycin, capreomycin, and p-amino-salicylic acid) antituberculosis drugs are highlighted for the conventional and radiometric methods. Participants should note that the new NCCLS tentative standard (Susceptibility Testing of Mycobacteria, Nocardia, and Other Aerobic Actinomycetes; Tentative Standard-Second Edition, NCCLS document M24-T2 [ISBN 1-56238-423-6] NCCLS, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087-1898,

USA, 2000) recommends testing streptomycin as a secondary drug and also adds ofloxacin and rifabutin to the list of recommended secondary drugs. Participants should note that these recommended combinations reflect the critical concentrations of antituberculosis drugs in 7H10 agar and those concentrations for the BACTEC method that directly correlate with the critical concentrations in the conventional method (1-4). When two concentrations are highlighted, such as for isoniazid and ethambutol, the lower concentration is the critical concentration that should always be included to determine whether the *M. tuberculosis* isolate is resistant.

Three strains of *M. tuberculosis* which have been previously reported as resistant to the low-level of INH were tested by participants in this shipment. **For Strain F**, resistance to the low-level concentration (0.2 µg/ml) of isoniazid (INH) by agar proportion (AP) was reported by 70% (23/33) of laboratories, while 73% (81/111) of laboratories reported resistance to the 0.1 µg/ml concentration of INH by the BACTEC method. Ninety-four percent (30/32) of laboratories reported the culture susceptible to the higher concentration of INH by BACTEC (0.4 µg/ml), and 97% (35/36) of laboratories performing AP at the higher concentration reported susceptible for this culture. Two percent of laboratories reported the culture resistant to pyrazinamide.

**For Strain G**, 79% (26/33) of laboratories reported resistance to INH 0.2 µg/ml with the AP method, and 75% (82/110) by BACTEC at 0.1 µg/ml. One hundred percent of laboratories reported susceptible results by AP at 1.0 µg/ml, and 97% (31/32) of laboratories reported susceptible results at 0.4 µg/ml by BACTEC. The strain was reported as susceptible to other primary drugs by almost all laboratories.

**Strain H** was reported as resistant to 0.2 µg/ml of INH by 97% (33/34) of laboratories with the AP method. Ninety-nine percent (111/112) of laboratories reported resistance to the lower concentration (0.1 µg/ml) of INH by BACTEC. Ninety-seven percent (31/32) of laboratories found the isolate susceptible at the higher 0.4 µg/ml of INH by BACTEC. Of the laboratories testing the isolate by AP, 94% (34/36) found the isolate susceptible at the 1.0 µg/ml of INH. Twelve per cent of the laboratories detected resistance to pyrazinamide at 100 µg/ml with BACTEC. Forty percent (10/25) of laboratories detected resistance to ethionamide at 5.0 µg/ml by AP, while 75% (3/4) of laboratories detected resistance using BACTEC with the same concentration. Reports have associated ethionamide resistance with low-level INH resistance (1, 9).

**Strain I** was fully susceptible to the primary drugs by almost all laboratories (except 2% (2/90) detected resistance to pyrazinamide 100 µg/ml and 1% (1/110) detected resistance to rifampin at 2.0 µg/ml both with the BACTEC method).

Our providing test results for all drugs that are reported to CDC should not be construed as a recommendation or endorsement for testing particular drugs or concentrations with patient isolates of *M. tuberculosis*-complex. It is assumed that some of the drugs are being tested for research purposes or potential use in the few referral institutions that may treat patients with *M. tuberculosis* isolates resistant to almost all standard drugs. Laboratories should not add drugs to their testing regimen without the consultation of physicians having expertise in treating multi-drug resistant tuberculosis. Laboratories may contact their local TB control program for referrals of physicians with experience and expertise in treating multi-drug resistant tuberculosis.

#### Nontuberculous Mycobacteria test results:

The aggregate test results are provided in Tables 2 and 3 for **Strain J**, *M. xenopi*, to facilitate comparison among laboratories. Table 2 represents either single or multiple drug concentrations with "breakpoint" susceptibility test results. Table 3 provides quantitative MIC test results. Fifty percent (5/10) of laboratories found this isolate resistant to INH at 0.2 µg/ml by

the AP method, while 100% (8) of laboratories found it to be resistant at 0.1 µg/ml by BACTEC. For AP, 90% (9/10) of laboratories reported susceptible at 1.0 µg/ml concentration and 100% reported susceptible at 5.0 µg/ml. Results reported at higher concentrations of the drug were susceptible with the BACTEC method.

Of participants who tested **Strain J** (*M. xenopi*) 36% (5/14) reported the isolate resistant to rifampin 1.0 µg/ml with AP; however, 100% (8) reported it susceptible to rifampin 2.0 µg/ml by BACTEC. For *M. xenopi* isolates resistant to 1.0 µg/ml of rifampin, the recommended secondary drugs for susceptibility testing are ethambutol, isoniazid, streptomycin, clarithromycin, amikacin, ciprofloxacin, trimethoprim sulfamethoxazole or sulfamethoxazole (7).

One hundred percent (13) of participants found this isolate (*M. xenopi*) resistant to ethambutol 5.0 µg/ml in AP, and one of three laboratories testing at the higher 10 µg/ml of ethambutol found it to be susceptible. All laboratories testing with BACTEC at the 2.5 µg/ml detected resistance.

In Table 3, laboratories reported agar proportion MIC results for *M. xenopi*. The isolate was resistant to concentrations of ethambutol greater than 5.0 and 8.0 µg/ml but susceptible to 16.0 µg/ml. One laboratory reported resistance to rifampin at 4.0 µg/ml while another reported susceptible at the same concentration by AP.

Anti-tuberculosis drugs to be tested for treatment of *M. xenopi* infections include isoniazid, rifampin and ethambutol. Similar to rifampin-resistant *M. kansasii*, *M. xenopi* infections may be very difficult to treat and all drugs should be tested (7, 10). Rifabutin is used in HIV-infected patients on treatment with protease inhibitors. Patient cultures which remain positive after 3 months of appropriate therapy should have susceptibility tests repeated (6, 7).

*M. xenopi* has been recovered from skin infections and bronchoscopy-associated pseudoinfections due to tap water contamination (6, 8). Isolates may grow in tap water at temperatures as high as 43-45 °C (6). There were 31 results reported for the 36 laboratories performing susceptibility testing on *M. xenopi*. Although this isolate is reported to grow well at 37 °C, it is not clear whether the “no growth” reported by some laboratories was related to incubation temperature or attempts to grow the isolate in broth microdilution. There have also been problems reported when attempting to grow *M. xenopi* in cation adjusted Mueller-Hinton broth (7).

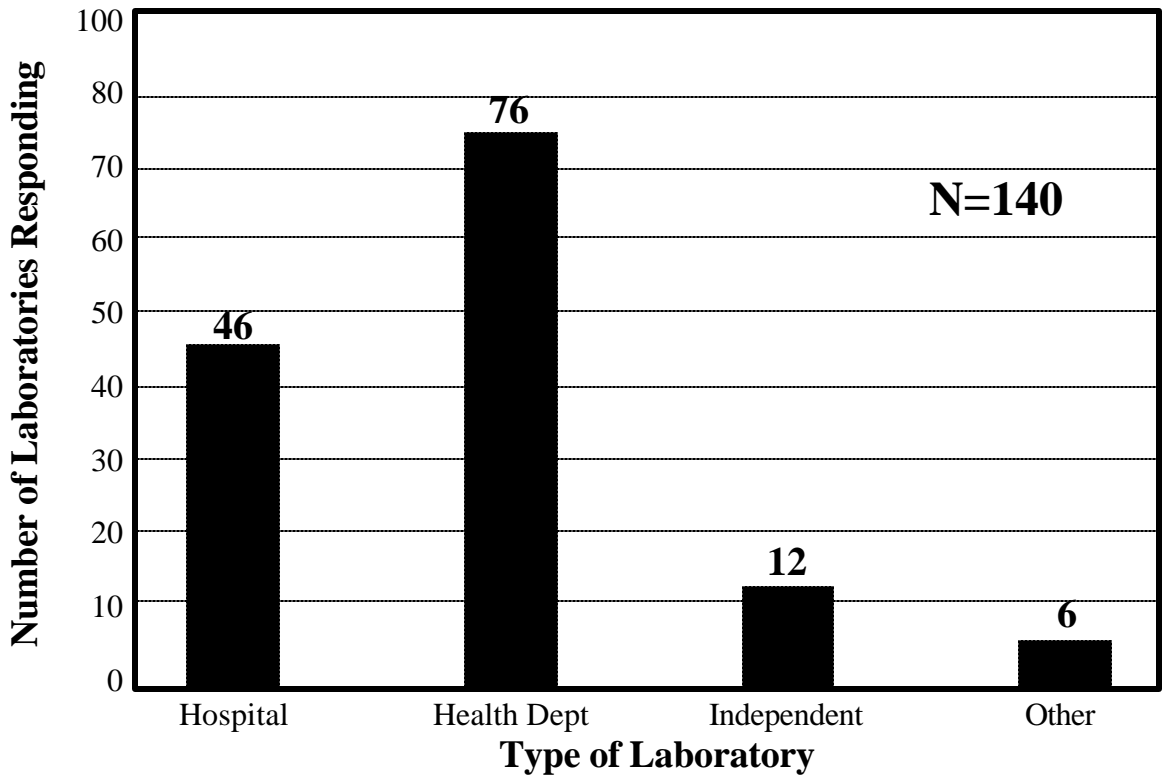
The addition of NTM strains to this performance evaluation program should not be interpreted as recommendations for laboratories to adopt NTM drug susceptibility testing, especially if the laboratory has limited experience with these tests and methods. We encourage laboratories that perform NTM drug susceptibility testing to consult recommendations, references, and physicians with expertise in infectious diseases when selecting test methods, drugs, and test interpretations.

Special thanks to the following persons for reviewing this report: Nancy G. Warren, Ph.D., Laboratory Corporation of America; Richard Wallace, M.D., Ph.D., and Barbara Brown-Elliott, M.S., University of Texas at Tyler, TX; Gail L. Woods, M.D., Merck Company; Wendy Gross, M.S., TB Reference Laboratory, West Haven, CT.

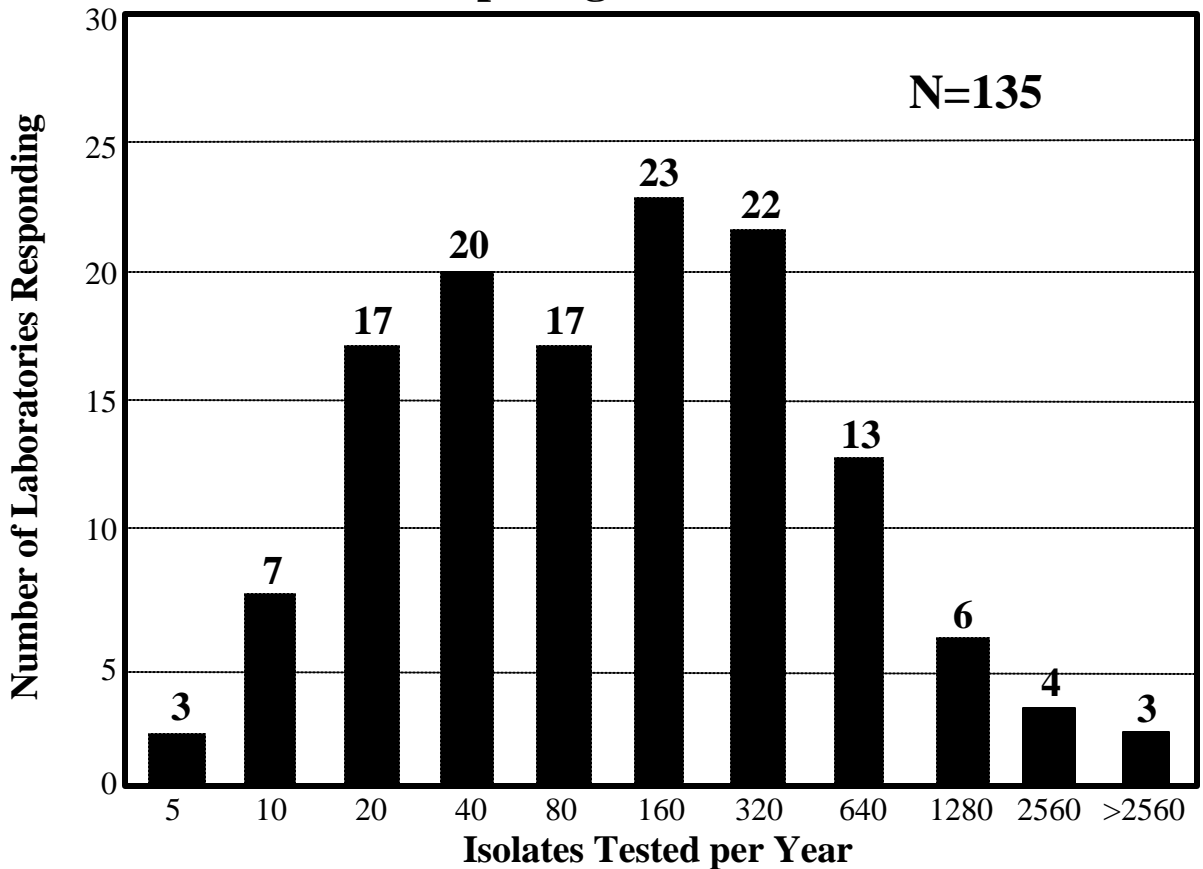
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**Figure 1. Primary Classification of Participating Laboratories**

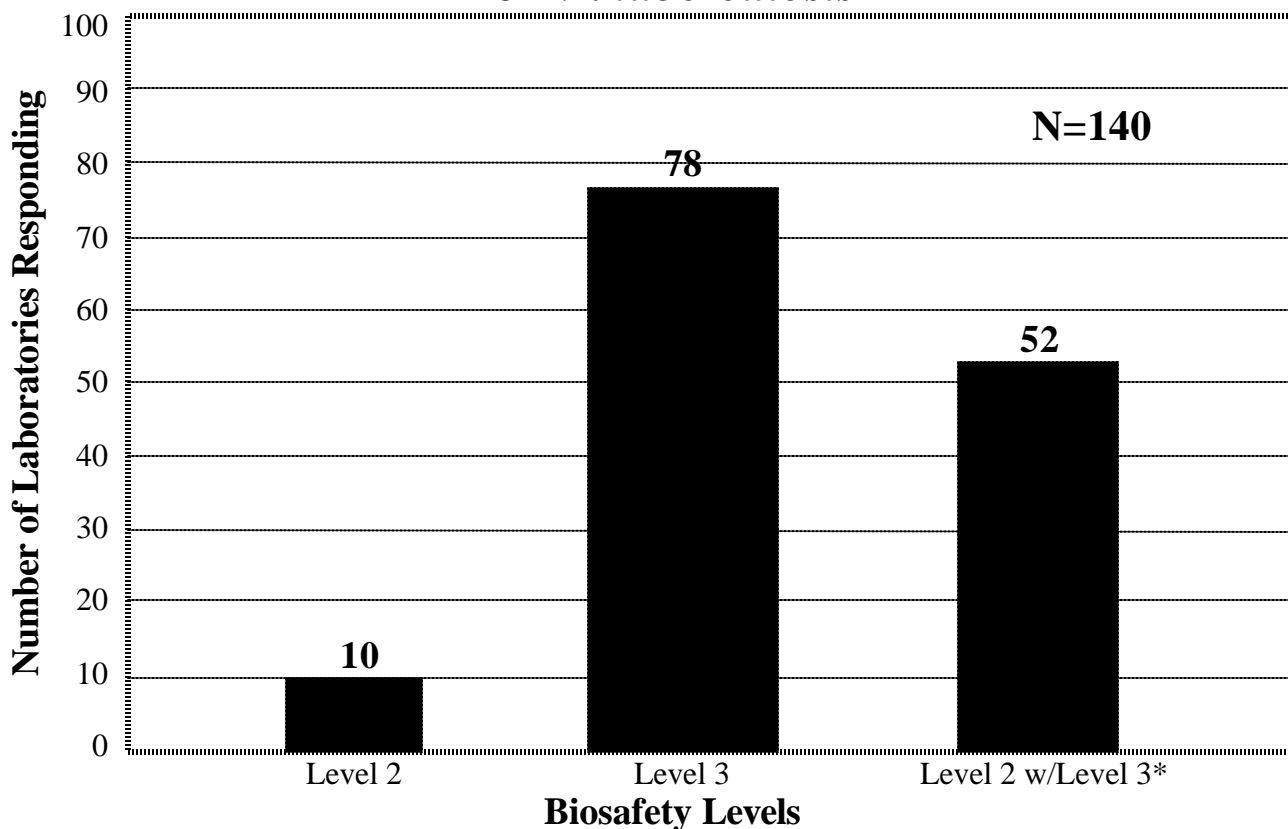


**Figure 2. 2001 Annual Volume of *M. tuberculosis* Isolates for Participating Laboratories**



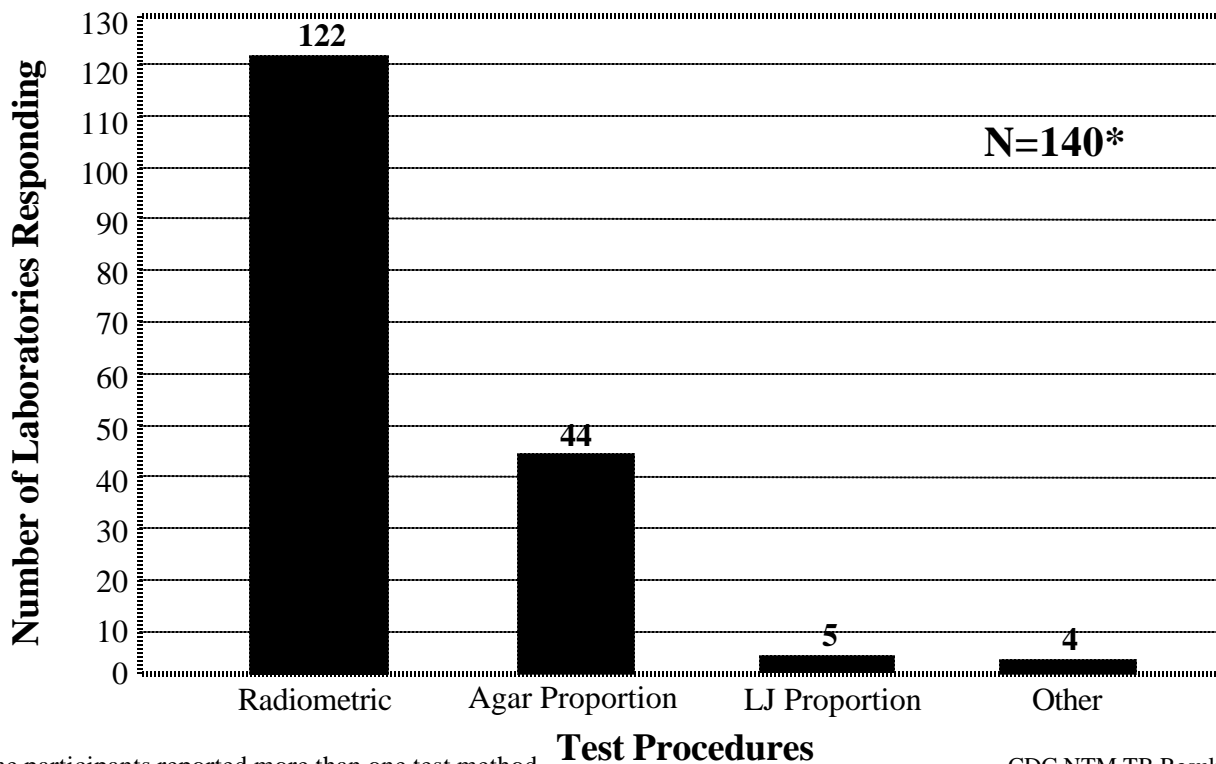
Group labels indicate upper limit of the group.

**Figure 3. Biosafety Levels of Participating Laboratories for *M. tuberculosis***



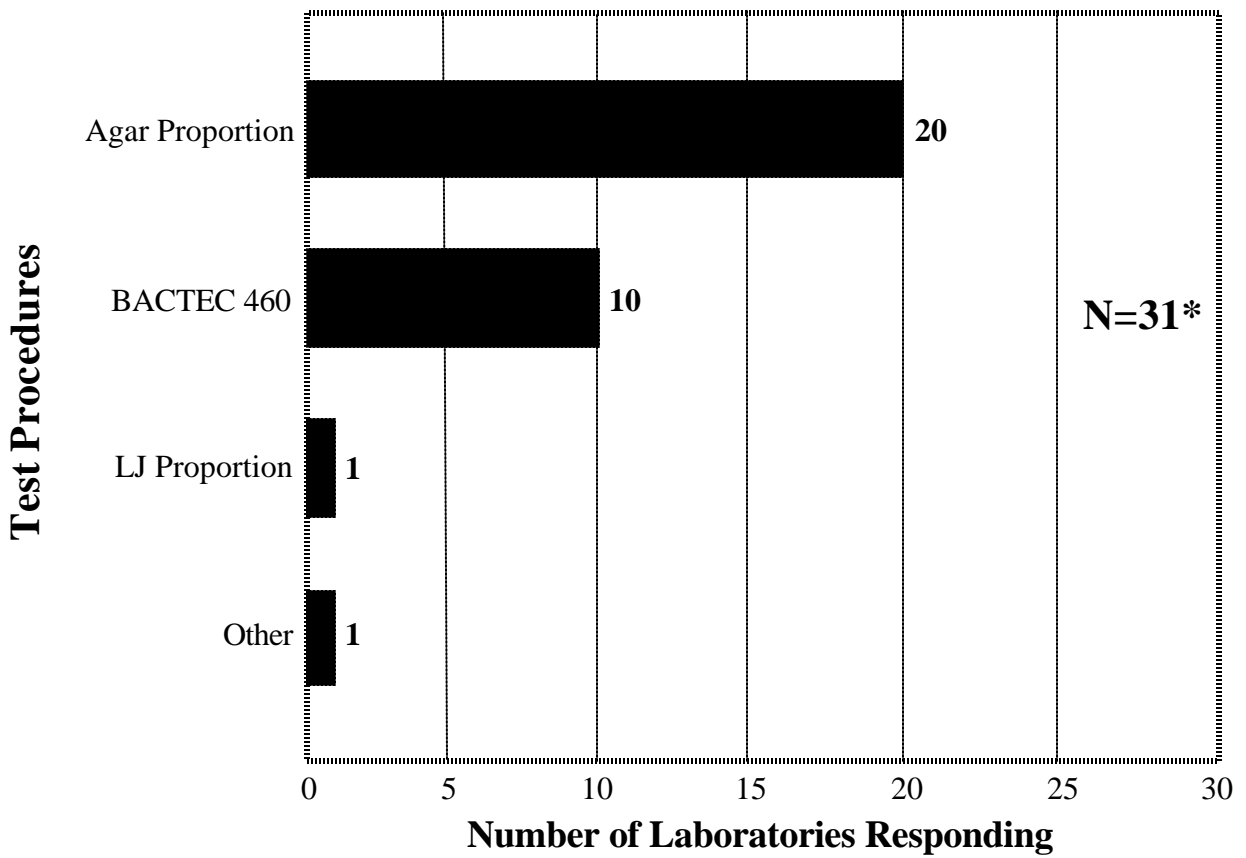
\* Biosafety level 2 for facilities with level 3 containment equipment

**Figure 4. Test Procedures used by Laboratories for *M. tuberculosis***



\* Some participants reported more than one test method

**Figure 5. Test Procedures used by Laboratories for Strain J - *M. xenopi***



\* One participant reported more than one test method



**Table 1. Participant Results for Culture F, *M. tuberculosis***

DRUG	Conc.	Test Method											
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.02	1		1									
Isoniazid	0.05										1		1
Isoniazid	0.10				30	81	111				2	2	4
Isoniazid	0.12		1	1									
Isoniazid	0.20	10	23	33	3	2	5	3	1	4	1		1
Isoniazid	0.25	1		1									
Isoniazid	0.40				30	2	32				1		1
Isoniazid	0.50	1		1									
Isoniazid	1.00	35	1	36	7		7	1		1			
Isoniazid	5.00	5		5	1		1						
Isoniazid	10.00							1		1			
Isoniazid	100.00							1		1			
Rifampin	0.50				2		2						
Rifampin	1.00	39		39	10		10	1		1	3		3
Rifampin	2.00				111		111						
Rifampin	5.00	4		4				1		1			
Rifampin	14.00										1		1
Rifampin	28.00										1		1
Rifampin	40.00							3		3			
Rifampin	50.00							1		1			
Rifampin	56.00										1		1
Pyrazinamide	50.00				1		1						
Pyrazinamide	64.00										1		1
Pyrazinamide	99.00				1		1						
Pyrazinamide	100.00				89	2	91				3		3
Ethambutol	1.00							1		1			
Ethambutol	1.60										1		1
Ethambutol	2.00							4		4			
Ethambutol	2.50				104	1	105						
Ethambutol	3.20										1		1
Ethambutol	3.75				2		2						
Ethambutol	4.00				1		1						
Ethambutol	5.00	34		34	8	1	9	1		1	3		3
Ethambutol	6.40										1		1
Ethambutol	7.50	5		5	14		14						
Ethambutol	10.00	12		12									
Streptomycin	1.00							1		1	2		2
Streptomycin	2.00	36		36	102		102						
Streptomycin	3.00				2		2						
Streptomycin	4.00				1		1	3		3			
Streptomycin	5.00							1		1			
Streptomycin	6.00				17		17						
Streptomycin	7.50											1	1
Streptomycin	10.00	27		27				1		1			
Streptomycin	15.00										1		1
Streptomycin	30.00										1		1

**Table 1. Participant Results for Culture F, *M. tuberculosis***

DRUG	Conc.	Test Method											
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ethionamide	1.00				1		1						
Ethionamide	1.25				1		1						
Ethionamide	2.00				1		1						
Ethionamide	2.50				2		2						
Ethionamide	5.00	25		25	4		4						
Ethionamide	8.00	1		1									
Ethionamide	10.00	4		4							1		1
Ethionamide	20.00								1		1		1
Ethionamide	40.00							2		2	1		1
Kanamycin	5.00	10		10	2		2						
Kanamycin	6.00	19		19									
Kanamycin	10.00							1		1			
Kanamycin	20.00							1		1			
Kanamycin	40.00							1		1			
Capreomycin	0.50										1		1
Capreomycin	1.00				1		1				1		1
Capreomycin	1.25				1		1						
Capreomycin	2.00				1		1						
Capreomycin	5.00				5		5						
Capreomycin	10.00	20		20									
Capreomycin	12.50										1		1
Capreomycin	25.00										1		1
Capreomycin	40.00							1		1			
Capreomycin	50.00										1		1
Cycloserine	12.00										1		1
Cycloserine	16.00							1		1			
Cycloserine	20.00								1	1			
Cycloserine	25.00	1		1									
Cycloserine	26.00										1		1
Cycloserine	30.00	12		12				1		1			
Cycloserine	32.00							1		1			
Cycloserine	40.00							1		1			
Cycloserine	48.00										1		1
Cycloserine	50.00	1		1									
Cycloserine	60.00	1		1									
p-Aminosalicylic acid	0.50							2		2			
p-Aminosalicylic acid	1.00							2		2			
p-Aminosalicylic acid	2.00	15		15									
p-Aminosalicylic acid	4.00				2		2						
p-Aminosalicylic acid	8.00	3		3									
p-Aminosalicylic acid	10.00	3		3									

**Table 1. Participant Results for Culture F, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Amikacin	0.50											1		1
Amikacin	1.00											1		1
Amikacin	1.37											1		1
Amikacin	2.00	1		1	1		1							
Amikacin	2.50				1		1							
Amikacin	3.75											1		1
Amikacin	4.00	3		3										
Amikacin	5.00				1		1							
Amikacin	6.00	5		5										
Amikacin	12.00	1		1										
Ofloxacin	0.50											1		1
Ofloxacin	1.00	5		5	2		2					1		1
Ofloxacin	1.65											1		1
Ofloxacin	2.00	6		6	5		5	1		1				
Ofloxacin	2.50											1		1
Ofloxacin	4.00	1	1	2										
Ofloxacin	5.00											1		1
Ciprofloxacin	0.50											1		1
Ciprofloxacin	1.00	4		4	4		4					1		1
Ciprofloxacin	1.60											1		1
Ciprofloxacin	2.00	9		9	2		2							
Ciprofloxacin	3.20											1		1
Ciprofloxacin	6.40											1		1
Levofloxacin	2.00				2		2							
Rifabutin	0.50	2		2										
Rifabutin	1.00	2		2	1		1							
Rifabutin	2.00	4		4										
Clofazimine	0.12				1		1							
Clofazimine	0.50	1		1	1		1					1		1
Clofazimine	1.00	2		2								1		1
Clarithromycin	6.00											1		1

**Table 1. Participant Results for Culture G, *M. tuberculosis***

DRUG	Conc.	Test Method											
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.02		1	1									
Isoniazid	0.05										1		1
Isoniazid	0.10				28	82	110				3	1	4
Isoniazid	0.12		1	1									
Isoniazid	0.20	7	26	33	2	3	5	4		4	1		1
Isoniazid	0.25	1		1									
Isoniazid	0.40				31	1	32				1		1
Isoniazid	0.50	1		1									
Isoniazid	1.00	35		35	7		7	1		1			
Isoniazid	5.00	4	1	5	1		1						
Isoniazid	10.00							1		1			
Isoniazid	100.00							1		1			
Rifampin	0.50				2		2						
Rifampin	1.00	39		39	10		10	1		1	3		3
Rifampin	2.00				110	1	111						
Rifampin	5.00	4		4				1		1			
Rifampin	14.00										1		1
Rifampin	28.00										1		1
Rifampin	40.00							3		3			
Rifampin	50.00							1		1			
Rifampin	56.00										1		1
Pyrazinamide	50.00				1		1						
Pyrazinamide	64.00										1		1
Pyrazinamide	99.00				1		1						
Pyrazinamide	100.00				91		91				3		3
Ethambutol	1.00							1		1			
Ethambutol	1.60										1		1
Ethambutol	2.00							4		4			
Ethambutol	2.50				105		105						
Ethambutol	3.20										1		1
Ethambutol	3.75				2		2						
Ethambutol	4.00				1		1						
Ethambutol	5.00	34		34	9		9	1		1	3		3
Ethambutol	6.40										1		1
Ethambutol	7.50	5		5	14		14						
Ethambutol	10.00	12		12									
Streptomycin	1.00							1		1	2		2
Streptomycin	2.00	36		36	102		102						
Streptomycin	3.00				2		2						
Streptomycin	4.00				1		1	2	1	3			
Streptomycin	5.00							1		1			
Streptomycin	6.00				17		17						
Streptomycin	7.50										1		1
Streptomycin	10.00	27		27				1		1			
Streptomycin	15.00										1		1
Streptomycin	30.00										1		1

**Table 1. Participant Results for Culture G, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Ethionamide	1.00				1		1							
Ethionamide	1.25				1		1							
Ethionamide	2.00				1		1							
Ethionamide	2.50				2		2							
Ethionamide	5.00	26		26	4		4							
Ethionamide	8.00	1		1										
Ethionamide	10.00	4		4								1		1
Ethionamide	20.00								1		1	1		1
Ethionamide	40.00							2			2	1		1
Kanamycin	5.00	10		10	2		2							
Kanamycin	6.00	19		19										
Kanamycin	10.00							1			1			
Kanamycin	20.00							1			1			
Kanamycin	40.00							1			1			
Capreomycin	0.50											1		1
Capreomycin	1.00				1		1					1		1
Capreomycin	1.25				1		1							
Capreomycin	2.00				1		1							
Capreomycin	5.00				5		5							
Capreomycin	10.00	20		20										
Capreomycin	12.50											1		1
Capreomycin	25.00											1		1
Capreomycin	40.00							1			1			
Capreomycin	50.00											1		1
Cycloserine	12.00											1		1
Cycloserine	16.00							1			1			
Cycloserine	20.00								1		1			
Cycloserine	25.00	1		1										
Cycloserine	26.00											1		1
Cycloserine	30.00	10	2	12				1			1			
Cycloserine	32.00							1			1			
Cycloserine	40.00							1			1			
Cycloserine	48.00											1		1
Cycloserine	50.00	1		1										
Cycloserine	60.00	1		1										
p-Aminosalicylic acid	0.50							2			2			
p-Aminosalicylic acid	1.00							2			2			
p-Aminosalicylic acid	2.00	15		15										
p-Aminosalicylic acid	4.00				2		2							
p-Aminosalicylic acid	8.00	3		3										
p-Aminosalicylic acid	10.00	3		3										

**Table 1. Participant Results for Culture G, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Amikacin	0.50											1		1
Amikacin	1.00											1		1
Amikacin	1.37											1		1
Amikacin	2.00	1		1	1		1							
Amikacin	2.50				1		1							
Amikacin	3.75											1		1
Amikacin	4.00	3		3										
Amikacin	5.00				1		1							
Amikacin	6.00	5		5										
Amikacin	12.00	1		1										
Ofloxacin	0.50											1		1
Ofloxacin	1.00	5		5	2		2					1		1
Ofloxacin	1.65											1		1
Ofloxacin	2.00	6		6	5		5	1		1				
Ofloxacin	2.50											1		1
Ofloxacin	4.00	2		2								1		1
Ofloxacin	5.00											1		1
Ciprofloxacin	0.50											1		1
Ciprofloxacin	1.00	3	1	4	4		4					1		1
Ciprofloxacin	1.60											1		1
Ciprofloxacin	2.00	9		9	2		2							
Ciprofloxacin	3.20											1		1
Ciprofloxacin	6.40											1		1
Levofloxacin	2.00				2		2							
Rifabutin	0.50	2		2										
Rifabutin	1.00	2		2	1		1							
Rifabutin	2.00	4		4										
Clofazimine	0.12				1		1							
Clofazimine	0.50	1		1	1		1					1		1
Clofazimine	1.00	1		1								1		1
Clarithromycin	6.00											1		1

**Table 1. Participant Results for Culture H, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Isoniazid	0.02		1	1										
Isoniazid	0.05											1		1
Isoniazid	0.10				1	111	112					4		4
Isoniazid	0.12		1	1										
Isoniazid	0.20	1	33	34		5	5	1	3	4		1		1
Isoniazid	0.25		1	1										
Isoniazid	0.40				31	1	32				1			1
Isoniazid	0.50		1	1										
Isoniazid	1.00	34	2	36	7		7	1		1				
Isoniazid	5.00	5		5	1		1							
Isoniazid	10.00							1		1				
Isoniazid	100.00							1		1				
Rifampin	0.50				2		2							
Rifampin	1.00	39		39	10		10	1		1	3			3
Rifampin	2.00				111		111							
Rifampin	5.00	4		4				1		1				
Rifampin	14.00										1			1
Rifampin	28.00										1			1
Rifampin	40.00							3		3				
Rifampin	50.00							1		1				
Rifampin	56.00										1			1
Pyrazinamide	50.00				1		1							
Pyrazinamide	64.00										1			1
Pyrazinamide	99.00					1	1							
Pyrazinamide	100.00				78	11	89				2	1		3
Ethambutol	1.00							1		1				
Ethambutol	1.60										1			1
Ethambutol	2.00							4		4				
Ethambutol	2.50				104		104							
Ethambutol	3.20										1			1
Ethambutol	3.75				2		2							
Ethambutol	4.00				1		1							
Ethambutol	5.00	33		33	8	1	9	1		1	1	2		3
Ethambutol	6.40										1			1
Ethambutol	7.50	5		5	13		13							
Ethambutol	10.00	12		12										
Streptomycin	1.00							1		1	1			1
Streptomycin	2.00	35	1	36	102		102							
Streptomycin	3.00				2		2							
Streptomycin	4.00				1		1	2	1	3				
Streptomycin	5.00							1		1				
Streptomycin	6.00				17		17							
Streptomycin	7.50										1			1
Streptomycin	10.00	25		25				1		1				
Streptomycin	15.00										1			1
Streptomycin	30.00										1			1

**Table 1. Participant Results for Culture H, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Ethionamide	1.00		1	1		1	1							
Ethionamide	1.25					1	1							
Ethionamide	2.00		1	1		1	1							
Ethionamide	2.50				1	1	2							
Ethionamide	5.00	15	10	25	1	3	4							
Ethionamide	8.00		1	1										
Ethionamide	10.00	3	1	4								1	1	
Ethionamide	20.00								1	1	2	1	1	
Ethionamide	40.00								1	1	2	1	1	
Kanamycin	5.00	9	1	10	2		2							
Kanamycin	6.00	19		19										
Kanamycin	10.00									1	1			
Kanamycin	20.00								1		1			
Kanamycin	40.00								1		1			
Capreomycin	0.50											1		1
Capreomycin	1.00				1		1					1		1
Capreomycin	1.25				1		1							
Capreomycin	2.00				1		1							
Capreomycin	5.00				5		5							
Capreomycin	10.00	19	1	20										
Capreomycin	12.50												1	1
Capreomycin	25.00											1		1
Capreomycin	40.00								1		1			
Capreomycin	50.00											1		1
Cycloserine	12.00											1		1
Cycloserine	16.00								1		1			
Cycloserine	20.00									1	1			
Cycloserine	25.00	1		1										
Cycloserine	26.00											1		1
Cycloserine	30.00	12		12					1		1			
Cycloserine	32.00								1		1			
Cycloserine	40.00								1		1			
Cycloserine	48.00											1		1
Cycloserine	50.00	1		1										
Cycloserine	60.00	1		1										
p-Aminosalicylic acid	0.50								2		2			
p-Aminosalicylic acid	1.00								2		2			
p-Aminosalicylic acid	2.00	15		15										
p-Aminosalicylic acid	4.00				1	1	2							
p-Aminosalicylic acid	8.00	3		3										
p-Aminosalicylic acid	10.00	3		3										



**Table 1. Participant Results for Culture H, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Amikacin	0.50											1		1
Amikacin	1.00											2		2
Amikacin	1.37											1		1
Amikacin	2.00	1		1	1		1							
Amikacin	2.50	1		1	1		1							
Amikacin	3.75											1		1
Amikacin	4.00	2	1	3										
Amikacin	5.00		1	1	1		1							
Amikacin	6.00	5		5										
Amikacin	12.00	1		1										
Ofloxacin	0.50											1		1
Ofloxacin	1.00	5		5	2		2					1		1
Ofloxacin	1.20	1		1										
Ofloxacin	1.65											1		1
Ofloxacin	2.00	6		6	5		5	1		1				
Ofloxacin	2.50											1		1
Ofloxacin	4.00	1	1	2										
Ofloxacin	5.00											1		1
Ciprofloxacin	0.50											1		1
Ciprofloxacin	1.00	4		4	4		4					2		2
Ciprofloxacin	1.60											1		1
Ciprofloxacin	2.00	9		9	2		2							
Ciprofloxacin	3.20											1		1
Ciprofloxacin	6.40											1		1
Levofloxacin	0.60	1		1										
Levofloxacin	2.00				2		2							
Rifabutin	0.50	2		2										
Rifabutin	1.00	2		2	1		1							
Rifabutin	2.00	4		4										
Clofazimine	0.12				1		1							
Clofazimine	0.50	1		1	1		1					1		1
Clofazimine	1.00	2		2								1		1
Clarithromycin	6.00											1		1

**Table 1. Participant Results for Culture I, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Isoniazid	0.02	1		1										
Isoniazid	0.05											1		1
Isoniazid	0.10				110		110					4		4
Isoniazid	0.12	1		1										
Isoniazid	0.20	29		29	4		4	4		4		1		1
Isoniazid	0.25	1		1										
Isoniazid	0.40				29		29							
Isoniazid	0.50	1		1										
Isoniazid	1.00	30		30	6		6	1		1				
Isoniazid	5.00	5		5										
Isoniazid	10.00							1		1				
Isoniazid	100.00							1		1				
Rifampin	0.50				2		2							
Rifampin	1.00	34		34	10		10	1		1		3		3
Rifampin	2.00				109	1	110							
Rifampin	5.00	2		2				1		1				
Rifampin	14.00											1		1
Rifampin	28.00											1		1
Rifampin	40.00							3		3				
Rifampin	50.00							1		1				
Rifampin	56.00											1		1
Pyrazinamide	50.00				1		1							
Pyrazinamide	64.00											1		1
Pyrazinamide	99.00					1	1							
Pyrazinamide	100.00				88	2	90					3		3
Ethambutol	1.00							1		1				
Ethambutol	1.60											1		1
Ethambutol	2.00							4		4				
Ethambutol	2.50				103		103							
Ethambutol	3.20											1		1
Ethambutol	3.75				2		2							
Ethambutol	4.00				1		1							
Ethambutol	5.00	30		30	9		9	1		1		3		3
Ethambutol	6.40											1		1
Ethambutol	7.50	4		4	13		13							
Ethambutol	10.00	9		9										
Streptomycin	1.00							1		1		2		2
Streptomycin	2.00	32		32	101		101							
Streptomycin	3.00				2		2							
Streptomycin	4.00				1		1	2	1	3				
Streptomycin	5.00							1		1				
Streptomycin	6.00				17		17							
Streptomycin	7.50											1		1
Streptomycin	10.00	22		22				1		1				
Streptomycin	15.00											1		1
Streptomycin	30.00											1		1

**Table 1. Participant Results for Culture I, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Ethionamide	1.00				1		1							
Ethionamide	1.25				1		1							
Ethionamide	2.00				1		1							
Ethionamide	2.50				1		1							
Ethionamide	5.00	21		21	4		4							
Ethionamide	8.00	1		1										
Ethionamide	10.00	4		4								1	1	
Ethionamide	20.00								1		1		1	1
Ethionamide	40.00							2			2	1		1
Kanamycin	5.00	9		9	2		2							
Kanamycin	6.00	16		16										
Kanamycin	10.00							1			1			
Kanamycin	20.00							1			1			
Kanamycin	40.00							1			1			
Capreomycin	0.50											1		1
Capreomycin	1.00				1		1					1		1
Capreomycin	1.25				1		1							
Capreomycin	2.00				1		1							
Capreomycin	5.00				4		4							
Capreomycin	10.00	18		18										
Capreomycin	12.50												1	1
Capreomycin	25.00											1		1
Capreomycin	40.00							1			1			
Capreomycin	50.00											1		1
Cycloserine	12.00											1		1
Cycloserine	16.00							1			1			
Cycloserine	20.00								1		1			
Cycloserine	25.00	1		1										
Cycloserine	26.00											1		1
Cycloserine	30.00	11		11				1			1			
Cycloserine	32.00							1			1			
Cycloserine	40.00							1			1			
Cycloserine	48.00											1		1
Cycloserine	50.00	1		1										
Cycloserine	60.00	1		1										
p-Aminosalicylic acid	0.50							2			2			
p-Aminosalicylic acid	1.00							2			2			
p-Aminosalicylic acid	2.00	12		12										
p-Aminosalicylic acid	4.00				2		2							
p-Aminosalicylic acid	8.00	3		3										
p-Aminosalicylic acid	10.00	2		2										

**Table 1. Participant Results for Culture I, *M. tuberculosis***

DRUG	Conc.	Test Method												
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Amikacin	0.50											1		1
Amikacin	1.00											1		1
Amikacin	1.37											1		1
Amikacin	2.00				1		1							
Amikacin	3.75											1		1
Amikacin	4.00	2		2										
Amikacin	5.00				1		1							
Amikacin	6.00	4		4										
Amikacin	12.00	1		1										
Ofloxacin	0.50											1		1
Ofloxacin	1.00	2		2	1		1					1		1
Ofloxacin	1.65											1		1
Ofloxacin	2.00	5		5	5		5	1		1				
Ofloxacin	2.50											1		1
Ofloxacin	4.00	2		2										
Ofloxacin	5.00											1		1
Ciprofloxacin	0.50											1		1
Ciprofloxacin	1.00	2		2	3		3					1		1
Ciprofloxacin	1.60											1		1
Ciprofloxacin	2.00	9		9	2		2							
Ciprofloxacin	3.20											1		1
Ciprofloxacin	6.40											1		1
Levofloxacin	2.00				2		2							
Rifabutin	0.50	1		1										
Rifabutin	1.00	1		1	1		1							
Rifabutin	2.00	3		3										
Clofazimine	0.12				1		1							
Clofazimine	0.50											1		1
Clofazimine	1.00	1		1								1		1
Clarithromycin	6.00											1		1

**Table 2. Participant Results for Culture J, *M. xenopi***

DRUG	Conc.	Test Method											
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Amikacin	1.00					1	1						
Amikacin	2.00				1		1						
Amikacin	4.00	1		1	1		1						
Amikacin	6.00	2		2									
Amikacin	10.00	2		2	1		1						
Amikacin	12.00	2		2									
Clofazimine	1.00	1		1									
Clarithromycin	1.00				1		1	1		1			
Clarithromycin	2.00				2		2						
Clarithromycin	3.00	4		4									
Clarithromycin	6.00										1		1
Clarithromycin	12.00										1		1
Clarithromycin	24.00										1		1
Clarithromycin	32.00	2		2	1		1						
Capreomycin	8.00		1	1									
Capreomycin	10.00	5	1	6									
Ciprofloxacin	1.00	2		2									
Ciprofloxacin	1.25				1		1						
Ciprofloxacin	2.00	6		6	2		2						
Ciprofloxacin	3.20										1		1
Ciprofloxacin	6.40										1		1
Cycloserine	12.00										1		1
Cycloserine	24.00										1		1
Cycloserine	30.00	1	2	3									
Cycloserine	48.00										1		1
Cycloserine	60.00	1		1									
Cefoxitin	30.00		1	1									
Ethambutol	2.00							1		1			
Ethambutol	2.50					7	7						
Ethambutol	3.75					1	1						
Ethambutol	4.00		1	1									
Ethambutol	5.00		13	13		2	2						
Ethambutol	7.50		1	1		2	2						
Ethambutol	10.00	1	2	3		1	1						
Isoniazid	0.02		1	1									
Isoniazid	0.10					8	8						
Isoniazid	0.20	5	5	10				1		1			
Isoniazid	0.40				3		3						
Isoniazid	1.00	9	1	10	1		1						
Isoniazid	5.00	3		3	2		2						
Kanamycin	5.00	1		1									
Kanamycin	6.00	6		6									
Kanamycin	16.00	1		1									

**Table 2. Participant Results for Culture J, *M. xenopi***

DRUG	Conc.	Test Method											
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ofloxacin	1.00	1		1	1		1						
Ofloxacin	1.25				1		1				1		1
Ofloxacin	2.00	2	1	3	1		1						
Ofloxacin	2.50										1		1
Ofloxacin	4.00	1		1									
Ofloxacin	5.00										1		1
p-Aminosalicylic acid	2.00	3		3									
p-Aminosalicylic acid	8.00	2		2									
Pyrazinamide	100.00					1	1						
Rifabutin	0.05				1		1						
Rifabutin	0.50	2		2	1		1						
Rifabutin	1.00	2		2	2		2						
Rifabutin	2.00	4		4	2		2						
Rifabutin	40.00							1		1			
Rifampin	1.00	9	5	14	2	1	3						
Rifampin	2.00				8		8						
Rifampin	5.00	3		3									
Rifampin	14.00										1		1
Rifampin	28.00										1		1
Rifampin	40.00							1		1			
Rifampin	50.00										1		1
Streptomycin	1.00				1		1						
Streptomycin	2.00	13		13	7		7						
Streptomycin	2.50										1		1
Streptomycin	3.00				1		1						
Streptomycin	4.00							1		1			
Streptomycin	6.00				1		1						
Streptomycin	10.00	11		11	1		1						
Streptomycin	16.00	1		1									
Sulfamethoxazole	32.00	1		1	1		1						
Ethionamide	5.00	5		5									
Ethionamide	7.50	1		1									
Ethionamide	8.00	1		1									
Ethionamide	10.00	3		3									
Trimethoprim-Sulfame	2.00	1		1									

**Table 3. Minimum Inhibitory Concentrations for Culture J, *M. xenopi***

DRUG	Test Method	MIC	S	R	Other	Sum
Amikacin	Agar proportion	1.00	1			1
Amikacin	Agar proportion	<2.50	1			1
Capreomycin	Agar proportion	16.00	1			1
Ciprofloxacin	Agar proportion	<0.50	1			1
Clarithromycin	Agar proportion	<0.06	1			1
Clarithromycin	Agar proportion	<0.16	1			1
Ethambutol	Agar proportion	>5.00		1		1
Ethambutol	Agar proportion	>8.00		1		1
Ethambutol	Agar proportion	16.00	1			1
Ethionamide	Agar proportion	4.00			1	1
Isoniazid	Agar proportion	4.00	1			1
Kanamycin	Agar proportion	8.00	1			1
Levofloxacin	Agar proportion	<0.60	1			1
Rifabutin	Agar proportion	<0.10	1			1
Rifabutin	Agar proportion	>0.10		1		1
Rifabutin	Agar proportion	0.20	1			1
Rifampin	Agar proportion	>1.00		1		1
Rifampin	Agar proportion	4.00	1	1		2
Streptomycin	Agar proportion	<2.00	1			1
Streptomycin	Agar proportion	8.00	1			1