

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position	Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates	
				codon	nucleotide	AA		AA	AA	Phenotype: S sensitive; R resistant	Method: 1 Proportion; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960			Pyrazinamidase activity
AA position	AA substitution													
				ins			-33	G					Juréen P. Antimicrob. Agents Chemother. 08	Sweden
	T7 promoteur						-22							
	Putative regulatory area			T			-12	C					Mphahlele M. J Clin Microbiol 08	Norway/South Africa
	Putative regulatory area			T			-12	G					Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
				ins			-11	A					Somskovi A. J. Clin. Microb. 07	USA
							-11	aacgt a->ggcagggt					Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
				A			-11	C					Scorpio A. Antimicrob. Agents Chemother. 97	USA
				A			-11	C					Jonmalung J. BMC Microbiology 11	Thailand
				A			-11	C					Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
				A			-11	G					Escalante P. Tuberc. Lung Dis. 98	Peru
				A			-11	G					Juréen P. Antimicrob. Agents Chemother. 08	Sweden
				A			-11	G					Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
				A			-11	G					Lee K.W. J Korean Med Sci 01	South Korea
				A			-11	G					Park S.K. BMC Infect. Dis. 01	Korea
	Mutation in promoter			A			-11	G					Cheng S-J. Antimicrob. Agents Chemother. 00	Canada
				A			-11	G					Mestdagh M. Antimicrob. Agents Chemother. 99	Scotland
	Putative regulatory area			A			-11	G					Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
	Mutation in promoter	microarray		A			-11	G					Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
	Mutation in promoter			A			-11	G					Portugal I. Antimicrob Agents Chemother 04	Portugal
				A			-11	G					Jonmalung J. BMC Microbiology 10	Thailand
				A			-11	G					Feuerrigel S. BMC Microbiology 2012	Germany
				A			-11	G					Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
				A			-11	G					Yoon JH World J Microbiol Biotechnol 14	Korea
				A			-11	T					Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
				A			-11	T					Napiorkowska A The Int J Tub Lung Dis 2014	Poland
	Putative regulatory area			T			-10	C					Mphahlele M. J Clin Microbiol 08	Norway/South Africa
				T			-7	C					Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
				T			-7	C					Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
				T			-7	G					Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
				del			-5	G					Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
				ins			-3	C					Juréen P. Antimicrob. Agents Chemother. 08	Sweden
				del		T	-1						Yoon JH World J Microbiol Biotechnol 14	Korea
	Y99D	TAC	T	Tyr	Y		295	G	GAC	Asp	D			
			del				1-561	del pncA					Suzuki Y. J. Clin. Microb. 02/16/12/14	Japan

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High frequency zone	Sensitive strain		wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
			codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive; R resistant	Méthod : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Méthod : 1 Wayne 2 other test		
AA position	AA substitution																	
				del			1-118	del pncA				1	R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore
1	Frameshift		ATG	del	Met	M	1	del 11 bp				2	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
1			ATG	del	Met	M	1	del 8 bp				1	R	1,3			Hou L. Epidemiol. Infect. 00	China
1	Frameshift	microarray	ATG	del	Met	M	1	del 11 bp				1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
1	Frameshift		ATG	del	Met	M	1	gacgt atg				1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
1	M1T		ATG	T	Met	M	2	C	ACG	Thr	T	1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
1	M1T		ATG	T	Met	M	2	C	ACG	Thr	T	6	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal
1	M1V		ATG	T	Met	M	2	C	ACG	Thr	T	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
1	M1I		ATG	G	Met	M	3	T	ATT	Ile	I	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
1	M1I		ATG	G	Met	M	3	A	ATA	Ile	I	1	R	4			Simons S.O. J. Clin. Microb. 12	Netherlands
2	R2R,T300T	mutant	CGG ACC	G C	Arg Thr	R T	6 300	A T	CGA ACT	Arg Thr	R T	7	S	1 1	positive	1	Bamaga M. Microb. Drug Resist. 01	UK
2	no published mutation		CGG		Arg	R												
3	A3P		GCG	G	Ala	A	7	C	CCG	Pro	P	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
3	A3P		GCG	G	Ala	A	7	C	CCG	Pro	P	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
3	A3P		GCG	G	Ala	A	7	C	CCG	Pro	P	1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
3	A3E		GCG	C	Ala	A	8	A	GAG	Glu	E	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
3	A3E		GCG	C	Ala	A	9	A	GAG	Glu	E	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
3	A3E		GCG	C	Ala	A	9	A	GAG	Glu	E	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
4	L4S		TTG	T	Leu	L	11	C	TCG	Ser	S	1	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
4	L4S		TTG	T	Leu	I	11	C	TCG	Ser	S	1	R	3			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
4	L4S		TTG	T	Leu	I	11	C	TCG	Ser	S	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
4	L4S		TTG	T	Leu	I	11	C	TCG	Ser	S	2	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
4	L4W		TTG	T	Leu	L	11	G	TGG	Trp	W	1	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
4	L4W		TTG	T	Leu	L	11	G	TGG	Trp	W	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
5	I5S		ATC	T	Ile	I	14	G	AGC	Ser	S	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
5	I5N		ATC	T	Ile	I	14	A	AAC	Asn	N	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
5	Frameshift		ATC	ins	Ile	I	14	TG				1	R	3			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
	Frameshift			del	Ile	I	14	TCAT CG				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
5	Frameshift		ATC	ins	Ile	I	15	C				1	R	3			Feuerrigel S. BMC Microbiology 2012	Germany
6	I6T		ATC	T	Ile	I	17	C	ACC	Thr	T	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
6	I6T		ATC	T	Ile	I	17	C	ACC	Thr	T	1	R	3			Wengren J. Antimicrob. Agents Chemother. 11	Sweden
6	I6T		ATC	T	Ile	I	17	C	ACC	Thr	T	3	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
6	I6T		ATC	T	Ile	I	17	C	ACC	Thr	T	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden
6	I6S		ATC	T	Ile	I	17	C	AGC	Ser	S	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
7	V7I		GTC	G	Val	V	19	A	ATC	Ile	I	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru
7	V7F		GTC	G	Val	V	19	T	TTC	Phe	F	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru
7	V7F		GTC	G	Val	V	19	T	TTC	Phe	F	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
7	V7F		GTC	G	Val	V	19	T	TTC	Phe	F	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
7	V7G		GTC	T	Val	V	20	G	GGC	Gly	G	2	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Yemen
7	V7G		GTC	T	Val	V	20	G	GGC	Gly	G	1	R	3	negative	1	Martila H.J. Antimicrob. Agents Chemother. 99	North Russia

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			codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive ; R resistant	Method : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method : 1 Wayne 2 other test		
AA position	AA substitution																	
7	V7G	microarray	GTC	T	Val	V	20	G	GGC	Gly	G	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
7	V7G		GTC	T	Val	V	20	G	GGC	Gly	G	1	R	1	negative	1	Bhju S. Infection, Genetics and Evolution 13	Brazil
7	V7G		GTC	T	Val	V	20	G	GGC	Gly	G	9	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
7	V7G		GTC	T	Val	V	20	G	GGC	Gly	G	1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
7	V7D		GTC	T	Val	V	20	A	GAC	Asp	D	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
7	V7A		GTC	T	Val	V	20	C	GCC	Ala	A	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
8	D8N		GAC	G	Asp	D	22	A	AAC	Asn	N	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
8	D8N		GAC	G	Asp	D	22	A	AAC	Asn	N	2	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
8	D8N		GAC	G	Asp	D	22	A	AAC	Asn	N	3	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
8	D8Y, L34R		GAC	G	Asp	D	22	T	TAC	Tyr	Y	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
34			CTG	T	Leu	L	104	G		Arg	R		R	1				
8	D8Y		GAC	G	Asp	D	22	T	TAC	Tyr	Y	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
8	D8Y		GAC	G	Asp	D	22	T	TAC	Tyr	Y	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
8	D8A		GAC	G	Asp	D	23	C	GCC	Ala	A	1	R	4			Tan Y. J. Clin. Microb. 14	China
8	D8A		GAC	G	Asp	D	23	C	GCC	Ala	A	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
8	Slipped-strand mispairing		GAC	ins			23	TCG				1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea
8	D8E		GAC	A	Asp	D	24	G	GAG	Glu	E	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
8	D8E		GAC	C	Asp	D	24	G	GAG	Glu	E	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
8	D8E		GAC	C	Asp	D	24	G	GAA	Glu	E	6	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
8	D8G		GAC	A	Asp	D	23	G	GGC	Gly	G	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
8	D8G		GAC	A	Asp	D	23	G	GGC	Gly	G	9	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
9	V9L		GTG	G	Val	V	25	T	TTG	Leu	L	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
9	V9G		GTG	T	Val	V	26	G	GGG	Gly	G	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
9	V9G		GTG	T	Val	V	26	G	GGG	Gly	G	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
9	V9A		GTG	T	Val	V	26	C	GCG	Ala	A	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
9	V9V		GTG	T	Val	V	27	C	GTC	Val	V	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru
10	Q10K		CAG	C	Gln	Q	28	A	AAG	Lys	K	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
10	Q10K		CAG	C	Gln	Q	28	A	AAG	Lys	K	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
10	Q10STOP		CAG	C	Gln	Q	28	T	TAG	STOP	Z	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
10	Q10STOP		CAG	C	Gln	Q	28	T	TAG	STOP	Z	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
10	Q10STOP		CAG	C	Gln	Q	28	T	TAG	STOP	Z	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia

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AA position	AA substitution																	
10	Q10STOP		CAG	C	Gln	Q	28	T	TAG	STOP	Z	1	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia
10	Q10STOP		CAG	C	Gln	Q	28	T	TAG	STOP	Z	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
10	Frameshift		CAG	del	Glu	Q	28	C				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	2	R	3			Somoskovi A. J. Clin. Microb. 07	USA
10	Q10P	microarray	CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
10	Q10P	microarray	CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Myanmar
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	4			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	3	negative	1	Sheen P. Tuberculosis 13	Peru, UK
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	4			Tan Y. J. Clin. Microb. 14	China
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	21	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
10	Q10P		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
10	Q10P, Y99D		CAG	A	Gln	Q	29	C	CCG	Pro	P	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
99			TAC	T	Tyr	Y	29	G	GAC	Asp	D							
10	Q10R		CAG	A	Gln	Q	29	G	CGG	Arg	R	1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
10	Q10R		CAG	A	Gln	Q	29	G	CGG	Arg	R	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
10	Q10R		CAG	A	Gln	Q	29	G	CGG	Arg	R	2	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
10	Q10R		CAG	A	Gln	Q	29	G	CGG	Arg	R	6	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
10	Q10R		CAG	A	Gln	Q	29	G	CGG	Arg	R	2	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
11	no published mutation		AAC		Asn	N												
12	D12N		GAC	G	Asp	D	34	A	AAC	Asn	N	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
12	D12N	microarray	GAC	G	Asp	D	34	A	AAC	Asn	N	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
12	D12N		GAC	G	Asp	D	34	A	AAC	Asn	N	1	R	3			Martin A. J. Antimicrob. Chemother. 06, 08	Eastern Europe
12	D12N		GAC	G	Asp	D	34	A	AAC	Asn	N	1	R	4			Piersimoni C J Clin Microb 13	Italy
12	D12N		GAC	G	Asp	D	34	A	AAC	Asn	N	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
12	D12A	microarray	GAC	A	Asp	D	35	C	GCC	Ala	A	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	1	ND				Post F.A. J. Infect. Dis. 04	USA/ South Africa
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	3	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	1	R	3			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	1	R	3	positive	1	Sheen P. J. Clin. Microbiol.09	Peru
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	2	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
12	D12A		GAC	A	Asp	D	35	C	GCC	Ala	A	6	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden

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AA position	AA substitution																	
12	D12E		GAC	A	Asp	D	35	C	GAG	Glu	E	2	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
12	D12G		GAC	A	Asp	D	35	G	GGC	Gly	G	9	R	3	8 pos, 1 neg	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
12	D12G		GAC	A	Asp	D	35	G	GGC	Gly	G	2	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
12	D12G		GAC	A	Asp	D	35	G	GGC	Gly	G	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden
12	Frameshift		GAC	ins			35	G				2	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
13	Frameshift			ins			37	GAC	T			1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
13	F13L		TTC	T	Phe	F	37	C	CTC	Leu	L	1	R	4			Tan Y. J. Clin. Microb. 14	China
13	F13S		TTC	T	Phe	F	38	C	TCC	Ser	S	1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
13	F13S		TTC	T	Phe	F	38	C	TCC	Ser	S	2	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
13	F13L		TTC	T	Phe	F	39	C	TTG	Leu	L	3	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
14	C14G		TGC	T	Cys	C	40	G	GGC	Gly	G	1	R	3	positive	1	Sheen P. J. Clin. Microbiol.09	Peru
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Myanmar
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
15	C14R	microarray	TGC	T	Cys	C	40	C	CGC	Arg	R	2	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	2	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	2	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	3	R	4			Daum L. J Clin Microbiol 12	Texas
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	1					Yoon JH World J Microbiol Biotechnol 14	Korea
14	C14R		TGC	T	Cys	C	40	C	CGC	Arg	R	1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
14	C14R, S65S		TGC	T	Cys	C	40	C	CGC	Arg	R	2	R	3			Somoskovi A. J. Clin. Microb. 07	USA
65	C14R, S65S		TCC	C	Ser	S	195	G	TCG	Ser	S		R	3				USA
14	C14Y		TGC	G	Cys	C	41	A	TAC	Tyr	Y	1	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia
14	C14Y		TGC	G	Cys	C	41	A	TAC	Tyr	Y	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
14	C14Y		TGC	G	Cys	C	41	A	TAC	Tyr	Y	1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea
14	C14W		TGC	C	Cys	C	42	A	TGG	Trp	W	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
14	C14W, Y103H		TGC	C	Cys	C	42	G	TGG	Trp	W	1	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia
103	C14W, Y103H			T	Tyr	Y	307	C		His	H		R	3				
14	C14STOP		TGC	G	Cys	C	41	A	TGA	STOP		2	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
14	C14STOP		TGC	G	Cys	C	41	A	TGA	STOP		1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
15	Frameshift			ins			44	C				1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
15	no published mutation		GAG		Glu	E												

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates	
		codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive; R resistant	Method: 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test			
17	G17D	GGC	G	Gly	G	50	A	GAC	Asp	D	2	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand	
17	G17S	GGC	G	GLY	G	49	A	AGC	Ser	S	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico	
17	G17S	GGC	G	GLY	G	49	A	AGC	Ser	S	1	R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore	
18	S18P, P54L	TCG	T	Ser	S	52	C	CCG	Pro	P	1	R	4			Tan Y. J. Clin. Microb. 14	China	
54		CCG	C	Pro	P		T	CTG	Leu	L								
18	Frameshift	TCG	ins			52	G				1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	Canada	
19	L19P	CTG	T	Leu	L	56	C	CCG	Pro	P	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA	
20	L19R	CTG	T	Leu	L	56	G	CCG	Arg	R	1	R	4	negative	1	Jonmalung J. BMC Microbiology 11	Thailand	
19	Frameshift	CTG	del			56					1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea	
20	Frameshift	GCG	del	Ala	A	59	C				1	R	1,3			Hou L. Epidemiol. Infect. 00 in Sandgren A. PLoS Med. 09	China	
20	A20A	CGC	G	Ala	A	60	A	GCA	Ala	A	1	S	3			Somoskovi A. J. Clin. Microb. 07	USA	
21	Frameshift	GTA	ins	Val	V	61	G				1	R	4			Piersimoni C J Clin Microb 13	Italy	
21	V21G	GTA	T	Val	V	62	G	GGA	Gly	G	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA	
21	V21E	GTA	T	Val	V	62	A	GAA	Glu	E	1	R	3			Lily Therese K. 12	India	
21	V21A	GTA	T	Val	V	62	C	GCA	Ala	A	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Germany	
22	no published mutation	ACC		Thr	T													
23	G23V	GGT	GT	Gly	G	62 63	TC	GTC	Val	V	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea	
23	no published mutation	GGT		Gly	G													
24	Frameshift	GGC	del			70	G				14	R	3			Somoskovi A. J. Clin. Microb. 07	USA	
24	Frameshift	GGC	del			70	G				7	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA	
24	G24D	GGC	G	Gly	G	71	A	GAC	Asp	D	1	R	3			Sheen P. J. Clin. Microbiol.09	Peru	
24	G24D	GGC	G	Gly	G	71	A	GAC	Asp	D	1	R	4			Tan Y. J. Clin. Microb. 14	China	
24	Frameshift	GGC	del	Gly	G	71	G				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA	
24	Frameshift	GGC	del			71	G				1	R	1,3			Hou L. Epidemiol. Infect. 00 in Sandgren A. PLoS Med. 09	China	
24	Frameshift	microarray	GGC	del		71	G				1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA	
24	Frameshift	GGC	del	Gly	G	71	G				3	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC	
24	Frameshift	microarray	GGC	del	Gly	71	G				1	R	3		2	Denkin S. J Med. Microbiol. 05	USA	
25	Frameshift	GCC	del			74	5bp				1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil	
25	A25E, A26G, A28D	GCC	CC	Ala	A	74 75	AA	GAA	Glu	E	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea	
26		GCC	C	Ala	A	77	G	GGG	Gly	G								
28		GCC	C	Ala	A	83	A	GAC	Asp	D								
25	Frameshift	GCC	ins			76	GC				2	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil	
26	Frameshift	GCG	del	Ala	A	77	G				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea	
26	A26G	GCG	C	Ala	A	77	G	GGG	Gly	G	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA	
26	Frameshift	mutant	GCG	del	Ala	A	78	G			4	R	1	negative	1	Bamaga M. Microb. Drug Resist. 01	UK	
			CGG	G	Arg	R	6	A	CGA	Arg								R
27	L27R	CTG	T	Leu	L	80	G	CGG	Arg	R	1	ND				Post F.A. J. Infect. Dis. 04	USA/ South Africa	
27	L27P	CTG	T	Leu	L	80	C	CCG	Pro	P	2	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan	
27	L27P	CTG	T	Leu	L	80	C	CCG	Pro	P	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico	
27	L27P	CTG	T	Leu	L	80	C	CCG	Pro	P	1	R	4	negative	1	Jonmalung J. BMC Microbiology 11	Thailand	
27	L27P	CTG	T	Leu	L	80	C	CCG	Pro	P	2	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Germany	
27	L27 del	CTG	del	Leu	L						1	R	4			Tan Y. J. Clin. Microb. 14	China	
28	A28T	GCC	G	Ala	A	82	A	ACC	Thr	T	1	S	4			Simons S.O. J. Clin. Microb. 12	Netherlands	
29	R29P	CGC		Arg	R				Pro	P	1	S	3	positive	1	Sheen P. Tuberculosis 13	Peru, UK	
29	no published mutation	CGC		Arg	R							R						
30	Frameshift	GCC	del	Ala	A	84	C				1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia	
31	I31T	ATC	T	Ile	I	92	C	ACC	Thr	T	9	S	4	positive	1	Jonmalung J. BMC Microbiology 10	Thailand	
31	I31T	ATC	T	Ile	I	92	C	ACC	Thr	T	3	R	4	positive	1	Jonmalung J. BMC Microbiology 10	Thailand	
31	I31S	ATC	T	Ile	I	92	G	AGC	Ser	S	1	R	4	positive	1	Jonmalung J. BMC Microbiology 10	Thailand	
31	I31S	ATC	T	Ile	I	92	G	AGC	Ser	T	2	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand	
32	no published mutation	AGC		Ser	S													
33	Frameshift	GAC	del	Asp	D	99	C				1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden	
34	Y34D	TAC	T	Tyr	Y	100	G	GAC	Asp	D	2	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan	
34	Y34D	TAC	T	Tyr	Y	100	G	GAC	Asp	D	1	R	3			Sheen P. J. Clin. Microbiol.09	Peru	
34	Y34S	TAC	A	Tyr	Y	101	C	TCC	Ser	S	2	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand	
34	R2R, nonsense	mutant	CGG	G	Arg	R	6	A	CGA	Arg	R	2	R	1	negative	1	Bamaga M. Microb. Drug Resist. 01	UK

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain		wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
			codon	nucleotide	AA	AA		Nucleotide substitution	AA	AA	Phenotype: S sensitive; R resistant		Method: 1 Proportion S; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test			
34	mutation STOP	mutant	TAC	C	Tyr	Y	102	G	TAG	STOP	Z	1	R	1	negative	1	Damaga M. Microb. Drug Resist. 07	UK
34	Y34STOP		TAC	C	Tyr	Y	102	G	TAG	STOP	Z	1	R	4			Simons S.O. J. Clin. Microb. 12	Netherlands
35	Frameshift		CTG	del			104	C				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
35	L35P		CTG	T	Leu	L	104	C	CCG	Pro	P	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
35	L35P		CTG	T	Leu	L	104	C	CCG	Pro	P	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
35	L35P		CTG	T	Leu	L	104	C	CCG	Pro	P	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
35	L35R		CTG	T	Leu	L	104	G	CGG	Arg	R	1	R	4			Lou G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
35	L35R		CTG	T	Leu	L	104	G	CGG	Arg	R	2	1 R, 1S (border line R)	3	positive	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
35	L35R		CTG	T	Leu	L	104	G	CGG	Arg	R	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
82	H82D		CAT	C	His	H	244	G	GAT	Asp	D	1	R	3				USA
35	Frameshift		CTG	ins	Leu	L	104	G				1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
36	Frameshift		GCC	del	Ala	A	106	del 5,3kb				1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
36	A36V		GCC	C	Ala	A	107	T	GTC	Val	V	2	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe
37	E37STOP		GAA	G	Glu	E	109	T	TAA	STOP	Z	3	R	4			Lou G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
38	no published mutation		GCG		Ala	A												
39	A39A	M.bovis	GCG	G	Ala	G	117	A	GCA	Ala	A	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
57	H57D		CAC	C	His	H	169	G	GAC	Asp	D		R					
40	no published mutation		GAC		Asp	D												
41	Y41H		TAC	T	Tyr	Y	121	C	CAC	His	H	1	R	1,3			Hou L. Epidemiol. Infect. 00	China
41	Y41STOP		TAC	C	Tyr	Y	123	A	TAA	STOP	Z	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand
41	Y41STOP		TAC	C	Tyr	Y	123	A	TAA	STOP	Z	2	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
41	Y41STOP		TAC	C	Tyr	Y	123	G	TAG	STOP	Z	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
41	Y41STOP		TAC	C	Tyr	Y	123	G	TAG	STOP	Z	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
42	no published mutation		CAT		His	H												
43	H43Y		CAC	C	His	H	127	T	TAC	Tyr	Y	1	S	4			Simons S.O. J. Clin. Microb. 12	Netherlands
43	H43P		CAC	A	His	H	128	C	CCC	Pro	P	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand
43	H43P		CAC	A	His	H	128	C	CCC	Pro	P	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
44	Frameshift		GTC	ins	Val	V	131	GG					ND				Post F.A. J. Infect. Dis. 04	USA/ South Africa
45	V45G		GTG	T	Val	V	134	G	GGG	Gly	G	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
45	V45A		GTG	T	Val	V	134	C	GCG	Ala	A	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
46	Frameshift		GCA	ins	Ala	A	136	G				1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Yemen
46	Frameshift		GCA	G	Ala	A	136	G				1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
46	A46P		GCA	G	Ala	A	136	C	CCA	Pro	P	1	R	4			Lou G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
46	A46S		GCA	G	Ala	A	136	T	TCA	Ser	S	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
46	A46E		GCA	C	Ala	A	137	A	GAA	Glu	E	1	R	1	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
46	A46E		GCA	C	Ala	A	137	A	GAA	Glu	E	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
46	A46V		GCA	C	Ala	A	137	A	GTA	Val	V	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
46	A46V		GCA	C	Ala	A	137	T	GTA	Val	V	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Yemen
46	A46V	microarray	GCA	C	Ala	A	137	T	GTA	Val	V	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
46	A46V		GCA	C	Ala	A	137	T	GTA	Val	V	6	R	1	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
46	A46V		GCA	C	Ala	A	137	T	GTA	Val	V	1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
46	A46A	M. canettii	GCA	A	Ala	A	138	G	GCG	Ala	A	9	R	3			Somoskovi A. J. Clin. Microb. 07	USA
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	3	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	10	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
47	T47S		ACC	A	Thr	T	139	T	TCC	Ser	S	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
47	T47P		ACC	A	Thr	T	139	C	CCC	Pro	P	1	R	1,3			Hou L. Epidemiol. Infect. 00 in Sandgren A. PLoS Med. 09	China

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position				Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates	
			codon	nucleotide	AA	AA	Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive; R resistant	Method: 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test			
																		AA
AA position	AA substitution																	
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	29	(S) retested R	3			Dormandy J. Chest 07	USA
47	T47A	microarray	ACC	A	Thr	T	139	G	GCC	Ala	A	3	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	1	R	3	positive	1	Werngren J. Antimicro. Agents Chemother. 11	Sweden
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	1	R	4			Tan Y. J. Clin. Microb. 14	China
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	1	S	1	positive (14 days)	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	42	S	3			Somoskovi A. J. Clin. Microb. 07	USA
47	T47A		ACC	A	Thr	T	139	G	GCC	Ala	A	2	S	3			Feuerrigel S. BMC Microbiology 2012	Germany
47	T47S		ACC	A	Thr	T	139	T	TCC	Ser	S	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
48	K48E		AAG	A	Lys	K	142	G	GAG	Glu	E	1					Yoon JH World J Microbiol Biotechnol 14	Korea
48	K48T		AAG	A	Lys	K	143	C	ACG	Thr	T	4	3R,1S	3			Sheen P. J. Clin. Microbiol.09	Peru
48	Frameshift, T100T	mutant	AAG del ACC	Lys C	K Thr	T	143 300	A T	A ACT	A Thr	T	1	R R	1,3 1	negative	1	Bamaga M. Microb. Drug Resist. 01	UK
49	D49H		GAC	G	Asp	D	145	C		His	H	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
49	D49N		GAC	G	Asp	D	145	A	AAC	Asn	N	27	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
49	D49N		GAC	G	Asp	D	145	A	AAC	Asn	N	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
49	D49A		GAC	A	Asp	D	146	C	GCC	Ala	A	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
49	D49A		GAC	A	Asp	D	146	C	GCC	Ala	A	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
49	D49A		GAC	A	Asp	D	146	C	GCC	Ala	A	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
49	D49A		GAC	A	Asp	D	146	C	GCC	Ala	A	3	S	1	positive	1	Bhaju S. Infection, Genetics and Evolution 13	Brazil
49	D49A, G75G		GAC	A	Asp	D	146	C	GCC	Ala	A	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
75			GGT	T	Gly	G		C	GGC	Gly	G		R	3				
49	D49V		GAC	A	Asp	D	146	T	GTC	Val	V	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
49	D49G		GAC	A	Asp	D	146	G	GGC	Gly	G	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
49	Frameshift		GAC	del	Asp	D	146	A	GC			1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
49	D49E		GAC	C	Asp	D	147	G	GAG	Glu	E	1	S	1	positive	1	Bhaju S. Infection, Genetics and Evolution 13	Brazil
49	D49E		GAC	C	Asp	D	147	G	GAG	Glu	E	1	S	4			Simons S.O. J. Clin. Microb. 12	Netherlands
50	Frameshift			del			150	T				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
50	no published mutation		TTC		Phe	F												
51	Frameshift		CAC	del	His	H	151-230	80 bp				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
51	H51N		CAC	C	His	H	151	A	AAC	Asn	N	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
51	H51Y		CAC	C	His	H	151	T	TAC	Tyr	Y	1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Scotland
51	H51Y		CAC	C	His	H	151	T	TAC	Tyr	Y	3	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
51	H51P		CAC	A	His	H	152	C	CCC	Pro	P	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand
51	H51P		CAC	A	His	H	152	C	CCC	Pro	P	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
51	H51P		CAC	A	His	H	152	C	CCC	Pro	P	1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
51	H51P		CAC	A	His	H	152	C	CCC	Pro	P	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
51	H51P		CAC	A	His	H	152	C	CCC	Pro	P	1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
51	H51P		CAC	A	His	H	152	C	CCC	Pro	P	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
51	H51R		CAC	A	His	H	152	G	CGC	Arg	R	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
51	H51R		CAC	A	His	H	152	G	CGC	Arg	R	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
51	H51R		CAC	A	His	H	152	G	CGC	Arg	R	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position	Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates					
				codon	nucleotide	AA		AA	Nucl eotid e substitution	AA substitution	AA			AA	Phéno type: S sensitive ; R resistant	Méthod : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinami dase activity	Méthod : 1 Wayne 2 other test
AA position	AA substitution																	
51	H51R		CAC	A	His	H	152	G	CGC	Arg	R	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand
51	H51R		CAC	A	His	H	152	G	CGC	Arg	R	13	R	1	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
51	H51R		CAC	A	His	H	152	G	CGC	Arg	R	1	R	4			Piersimoni C J Clin Microb 13	Italy
51	H51R		CAC	A	His	H	152	G	CGC	Arg	R	4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
51	H51Q		CAC	C	His	H	153	G	CAG	Gln	Q	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
51	H51Q		CAC	C	His	H	153	A	CAA	Gln	Q	2	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
51	H51Q		CAC	C	His	H	153	A	CAA	Gln	Q	2	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Poland
51	H51Q	microarray	CAC	C	His	H	153	A	CAA	Gln	Q	2	R	3			Somoskovi A. J. Clin. Microb. 07	USA
51	H51Q	microarray	CAC	C	His	H	153	A	CAA	Gln	Q	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
51	H51Q	microarray	CAC	C	His	H	153	A	CAA	Gln	Q	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
51	H51Q		CAC	C	His	H	153	A	CAA	Gln	Q	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
51	H51Q		CAC	C	His	H				Gln	Q	1	R	3			Werngren J. Antimicro. Agents Chemother. 11	Sweden
51	H51Q		CAC	C	His	H	153	A	CAA	Gln	Q	7	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
51	H51Q		CAC	C	His	H	153	A	CAA	Gln	Q	4	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
52	no published mutation		ATC		Ile	I												
53	D53N, frameshift		GAC	G	Asp	D	157	A	AAC	Asn	N	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
	Frameshift			ins			349	CAC TG										Japan
53	D53A		GAC	A	Asp	D	158	C	GCC	Ala	A	1	R	1	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
53	D53A		GAC	del	Asp	D	158	del A				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
54	P54S		CCG	C	Pro	P	160	T	TCG	Ser	S	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
54	P54S		CCG	C	Pro	P				Ser	S	1	R	3			Werngren J. Antimicro. Agents Chemother. 11	Sweden
54	P54S		CCG	C	Pro	P	160	T	TCG	Ser	S	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
54	P54T		CCG	C	Pro	P	160	A	ACG	Thr	T	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
54	P54T		CCG	C	Pro	P	161	A	ACG	Thr	T	1	R	1,3			Hou L. Epidemiol. Infect. 00	China
54	Frameshift		CCG	del	Pro	P	161	del C				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
54	P54Q		CCG	C	Pro	P	161	A	CAG	Gln	Q	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
54	P54Q		CCG	C	Pro	P	161	A	CAG	Gln	Q	4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
54	P54L		CCG	C	Pro	P	161	T	CTG	Leu	L	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
54	P54L		CCG	C	Pro	P	161	T	CTG	Leu	L	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
54	P54L		CCG	C	Pro	P	161	T	CTG	Leu	L	6	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
54	P54L		CCG	C	Pro	P	161	T	CTG	Leu	L	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
54	P54L		CCG	C	Pro	P	161	T	CTG	Leu	L	3	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
54	P54L		CCG	C	Pro	P				Leu	L	1	R	3		1	Werngren J. Antimicro. Agents Chemother. 11	Sweden
54	P54L		CCG	C	Pro	P	161	T	CTG	Leu	L	4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
54	P54R		CCG	C	Pro	P	161	G	CGG	Gln	Q	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position	Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates					
				codon	nucl. AA	AA		Phenotype: S sensitive; R resistant	Method: 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test							
AA position	AA substitution																	
54	P54delG		CCG	G	Pro	P	161	del G	CC		1		negative	1	Scorpio A. Nature 96	USA		
54	Frameshift		CCG		Pro	P	162				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA	
55	no published mutation		GGT		Gly	G												
56	no published mutation		GAC		Asp	D												
57	H57D		CAC	C	His	H	169	G	GAC	Asp	D	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
57	H57D		CAC	C	His	H	169	G	GAC	Asp	D	2	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
57	H57D	M. bovis	CAC	C	His	H	169	G	GAC	Asp	D	1	R	3			Scorpio A. J Clin Microbiol 97	USA
57	H57D	BCG	CAC	C	His	H	169	G	GAC	Asp	D	6	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Japan
57	H57D	M. bovis deer	CAC	C	His	H	169	G	GAC	Asp	D	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Japan
57	H57D	M. bovis	CAC	C	His	H	169	G	GAC	Asp	D	99/117 (85%)	R	1	negative	1	Espinosa L.E. J Clin Microb (Scorpio 96 )	Spain
57	H57D	M. bovis	CAC	C	His	H	169	G	GAC	Asp	D	1	R	3			Hannan M. M. J. Clin. Microb. 01	USA
57	H57D	BCG	CAC	C	His	H	169	G	GAC	Asp	D	1	R	3			Hannan M. M. J. Clin. Microb. 01	USA
57	H57D	BCG	CAC	C	His	H	169	G	GAC	Asp	D	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
57	H57D	BCG microarray	CAC	C	His	H	169	G	GAC	Asp	D	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
57	H57D		CAC	C	His	H	169	G	GAC	Asp	D	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
57	H57D	microarray M.bovis	CAC	C	His	H	169	G	GAC	Asp	D	3	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
57	H57D	BCG	CAC	C	His	H	169	G	GAC	Asp	D	43	R	3			Somoskovi A. J. Clin. Microb. 07	USA
57	H57D	M. bovis	CAC	C	His	H	169	G	GAC	Asp	D	45	R	3			Somoskovi A. J. Clin. Microb. 07	USA
57	H57D	BCG	CAC	C	His	H	169	G	GAC	Asp	D	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
57	H57D	BCG	CAC	C	His	H	169	G	GAC	Asp	D	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
57	H57D	M. bovis	CAC	C	His	H	169	G	GAC	Asp	D	1	R	4			Piersimoni C J Clin Microb 13	Italy
57	H57D		CAC	C	His	H	169	G	GAC	Asp	D	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden
57	H57D		CAC	C	His	H	169	G	GAC	Asp	D	10	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
57	H57P		CAC	A	His	H	170	C	CCC	Pro	P	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
57	H57P		CAC	A	His	H	170	C	CCC	Pro	P	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
57	H57P		CAC	A	His	H	170	C	CCC	Pro	P	1	R	3	negative	1	Brown T.J. J. Med. Microbiol. 00	Turkey/UK
57	H57R		CAC	A	His	H	170	G	CGC	Arg	R	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
57	H57R		CAC	A	His	H	170	G	CGC	Arg	R	14	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
57	H57Y		CAC	C	His	H	169	T	TAC	Tyr	Y	2	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
57	H57Y		CAC	C	His	H	169	T	TAC	Tyr	Y	1	R	4			Simons S.O. J. Clin. Microb. 12	Netherlands
57	H57Y		CAC	C	His	H	169	T	TAC	Tyr	Y	1	R	4			Tan Y. J. Clin. Microb. 14	China
57	H57Y		CAC	C	His	H	169	T	TAC	Tyr	Y	5	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
57	H57Q		CAC	C	His	H	171	T	CAG	Gln	Y	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
58	F58L		TTC	T	Phe	F	172	C	CTC	Leu	L	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru
58	F58L		TTC	T	Phe	F	172	C	CTC	Leu	L	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
58	F58L		TTC	T	Phe	F	172	C	CTC	Leu	L	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
58	F58L		TTC	T	Phe	F	172	C	CTC	Leu	L	1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position	Substitution			Phenotype	Pyrazinamidase		Publication	Origin of isolates							
				codon	nucleotide	AA		AA	No. of isolates			Phenotype: S sensitive; R resistant	Method: 1 Wayne 2 other test					
AA position	AA substitution																	
58	F58L		TTC	T	Phe	F	172	C	CTC	Leu	L	7	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
58	Frameshift		TTC	del	Phe	F	172	T				12	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
58	F58S		TTC	T	Phe	F	173	C	TCC	Ser	S	1	R	4			Tan Y. J. Clin. Microb. 14	China
58	F58L		TTC	C	Phe	F	174	G	TTG	Leu	L	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
58	F58L		TTC	C	Phe	F	174	G	TTG	Leu	L	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Canada
58	F58L		TTC	C	Phe	F	174			Leu	L	1	R	3	negative	1	Davies A.P. J. Clin. Microbiol. 00	UK
58	F58L		TTC	C	Phe	F				Leu	L	2	R	3	negative	1	Werngren J. Antimicrob. Agents Chemother. 11	Sweden
59	S59P		TCC	T	Ser	S	175	C	CCC	Pro	P	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
59	S59P		TCC	T	Ser	S	175	C	CCC	Pro	P	1	R	3	negative	1	Brown T.J. J. Med. Microbiol. 00	Turkey/UK
59	S59P		TCC	T	Ser	S	175	C	CCC	Pro	P	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
60	G60G	silent	GGC	C	Gly	G	180	T	GGT	Gly	G	2	S	2	positive	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
60	G60G, T142M		GGC	C	Gly	G	180	T	GGT	Gly	G	1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea
142			ACG	A	Thr	T	425	T	ATG	Met	M	1						
61	T61P,V139A		ACA	A	Thr	T	181	C	CCA	Pro	P	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
							416	C										
61	T61P		ACA	T	Thr	T	181	C	CCA	Pro	P	1	R	1	positive	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
61	Frameshift		ACA	ins			182	ins 5bp				3	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
61	Frameshift		ACA	del			182-183	CA	A			1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
62	P62T		CCG	C	Pro	P	184	A	ACG	Thr	T	1	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia
62	Frameshift		CCG	ins			184/185	T	TTCCG			1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
							290	T					R	1				
62	P62L		CCG	C	Pro	P	185	T	CTG	Leu	L	1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
62	P62L		CCG	C	Pro	P	185	T	CTG	Leu	L	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
63	P62L		CCG	C	Pro	P	185	T	CTG	Leu	L	3	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
62	P62R		CCG	C	Pro	P	185	G	CGG	Arg	R	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
62	P62Q		CCG	C	Pro	P	185	A	CAG	Gln	Q	1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Azerbaijan
62	P62Q		CCG	C	Pro	P	185	A	CAG	Gln	Q	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
62	Frameshift		CCG	ins			185	4 bp				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
62	Frameshift		CCG	del	Pro	P	186	C				3	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
62	Frameshift		CCG	ins			186	A				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
63	D63H		GAC	G	Asp	D	187	C	CAC	His	H	1	R	1	negative	1	Scorpio A. Nature 96	USA (Colorado)
63	D63A		GAC	A	Asp	D	188	C	GCC	Ala	A	1	R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore
63	D63A		GAC	A	Asp	D	188	C	GCC	Ala	A	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
63	D63A		GAC	A	Asp	D	188	C	GCC	Ala	A	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
63	D63G		GAC	A	Asp	D	188	G	GGC	Gly	G	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
63	D63G		GAC	A	Asp	D	188	G	GGC	Gly	G	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Yemen
63	D63G		GAC	A	Asp	D	188	G	GGC	Gly	G	2	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia
63	D63G		GAC	A	Asp	D	188	G	GGC	Gly	G	1	R	3			Martin A. J. Antimicrob. Chemother. 06, 08	Eastern Europe

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain		wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
			codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive; R resistant	Method : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method : 1 Wayne 2 other test		
AA position	AA substitution																	
64	D63G		GAC	A	Asp	D	188	G	GGC	Gly	G	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
64	D63G		GAC	A	Asp	D	188	G	GGC	Gly	G	4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
63	Frameshift		GAC	ins	Asp	D	188	GG			G	1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
64	Y64D		TAT	T	Tyr	Y	190	G	GAT	Asp	D	1	R	3			Martin A. J. Antimicrob. Chemother. 06, 08	Eastern Europe
64	Y64D		TAT	T	Tyr	Y	190	G	GAT	Asp	D	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
64	Y64D		TAT	T	Tyr	Y	190	G	GAT	Asp	D	1	R	3	negative	1		
64	Y64D		TAT	T	Tyr	Y	190	G	GAT	Asp	D	1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea
64	Frameshift		TAT	T	Tyr	Y	192	A	TAG	STOP		3	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
64	Frameshift		TAT	ins	Tyr	Y	192	A	TAA	STOP		1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
64	Frameshift		TAT	ins	Tyr	Y	192	A	TAA	STOP		1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
64	Frameshift	microarray	TAT	ins	Tyr	Y	192	A	TAA	STOP		1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
64	Frameshift		TAT	ins	Tyr	Y	192	A				1	R	3			Feuerrigel S. BMC Microbiology 2012	Germany
65	Frameshift		TCC	ins	Ser	S	192	A				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
65	Frameshift		TCC	ins	Ser	S	193	A				2	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
65	Frameshift		TCC	ins	Ser	S	193	A				1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
65	Frameshift		TCC	ins	Ser	S	193	A				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
65	Frameshift		TCC	ins	Ser	S	193	TATC AGG				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
65	S65S	silent	TCC	C	Ser	S	195	T	TCT	Ser	S	1	S	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
65	S65S	silent	TCC	C	Ser	S	195	T	TCT	Ser	S	2	S	3	positive	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
65	S65S	silent	TCC	C	Ser	S	195	T	TCT	Ser	S	2	S	3			Somoskovi A. J. Clin. Microb. 07	USA
65	S65S	silent	TCC	C	Ser	S	195	T	TCT	Ser	S	7	S	2	positive	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
65	S65S	silent	TCC	C	Ser	S	195	T	TCT	Ser	S	1	S	3			Denkin S. J Med. Microbiol. 05	USA
65	S65S	silent	TCC	C	Ser	S	195	T	TCT	Ser	S	1	S	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
65	S65S, W68R	microarray	TCC	C	Ser	S	195	T	TCT	Ser	S	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
68			TGG	T	Trp	W	202	C	CGG	Arg	R							
65	Frameshift		TCC	del			195-263	del 68 bp				1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Azerbaijan
66	S66P		TCG	T	Ser	S	196	C	CCG	Pro	P	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
66	S66P		TCG	T	Ser	S	196	C	CCG	Pro	P	1	R	4			Tan Y. J. Clin. Microb. 14	China
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Canada
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	1	R	3			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	1	R				Yoon JH World J Microbiol Biotechnol 14	Korea

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt					Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
		codon	nucleotide	AA	AA			Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive ; R resistant	Method : 1 Proportions; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method : 1 Wayne 2 other test		
AA position	AA substitution																	
67	S67P		TCG	T	Ser	S	199	C	CCG	Pro	P	2	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
68	W68R		TGG	T	Trp	W	202	C	CGG	Arg	R	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
68	W68R		TGG	T	Trp	W	202	C	CGG	Arg	R	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
68	W68R		TGG	T	Trp	W	202	C	CGG	Arg	R	3	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
68	W68R		TGG	T	Trp	W	202	C	CGG	Arg	R	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
68	W68R		TGG	T	Trp	W	202	C	CGG	Arg	R	2	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
68	W68R		TGG	T	Trp	W	202	C	CGG	Arg	R	7	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
68	W68G		TGG	T	Trp	W	202	G	GGG	Gly	G	7	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
68	W68G		TGG	T	Trp	W	202	G	GGG	Gly	G	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
68	W68G		TGG	T	Trp	W	202	G	GGG	Gly	G	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
68	W68G		TGG	T	Trp	W	202	G	GGG	Gly	G	16	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
68	W68G		TGG	T	Trp	W	202	G	GGG	Gly	G	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
68	W68L		TGG	G	Trp	W	203	T	TTG	Leu	L	2	R	4			Chan R.C.Y. J Antimicrob. Chemother. 07	Hong Kong
68	W68L		TGG	G	Trp	W	203	T	TTG	Leu	L	2	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
68	W68L		TGG	G	Trp	W	203	T	TTG	Leu	L	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
68	W68S		TGG	G	Trp	W	203	C	TCG	Ser	S	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
68	W68S		TGG	G	Trp	W	203	C	TCG	Ser	S	1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
68	W68STOP		TGG	G	Trp	W	203	A	TAG	STOP		2	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
69	W68STOP	mutant in vitro	TGG	T	Trp	W	203	A	TAG	STOP		1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
69	W68STOP		TGG	T	Trp	W	203	A	TAG	STOP		1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
68	W68C		TGG	T	Trp	W	204	G	TGC	Gly	G	5	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
68	W68C		TGG	T	Trp	W	204	G	TGT	Gly	G	1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
69	P69A		CCA	C	Pro	P	205	G	GCA	Ala	A	1	R	1	negative	1	Bhuju S. Infection, Genetics and Evolution 13	Brazil
69	P69R		CCA	C	Pro	P	206	G	CGA	Arg	R	2	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
69	P69R		CCA	C	Pro	P	207	G	CGA	Arg	R	1	R	1,3			Hou L. Epidemiol. Infect. 00 in Sandgren A. PLoS Med. 09	China
69	P69L		CCA	C	Pro	P	206	T	CTA	Leu	L	1	R	1	negative	1	Lemaître N. Antimicrob. Agents Chemother. 99	France
70	P70R	microarray	CCA	C	Pro	P	207	G	CGA	Arg	R	2	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
71	H71Y		CAT	C	His	H	211	T	TAT	Tyr	Y	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
71	H71Y		CAT	C	His	H	211	T	TAT	Tyr	Y	1	R	3	positive	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
71	H71Y		CAT	C	His	H	211	T	TAT	Tyr	Y	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
71	H71Y		CAT	C	His	H	211	T	TAT	Tyr	Y	1	R	3			McCammon M.T. Antimicrob. Agents Chemother. 05	USA/Texas/Mexico
71	H71Y		CAT	C	His	H	211	T	TAT	Tyr	Y	1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt											Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
		codon	nucleotide	AA	AA	Nucleotide substitution	AA substitution	AA	AA	Phenotype: S sensitive; R resistant	Method : 1 Proportions; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity		Method : 1 Wayne 2 other test										
															Phenotype	Method	Pyrazinamidase		Method					
AA position	AA substitution																							
71	H71Y	CAT	C	His	H	211	T	TAT	Tyr	Y	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico							
71	H71Y	CAT	C	His	H	211	T	TAT	Tyr	Y	2	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium							
71	H71D	CAT	C	His	H	211	G	GAT	Asp	D	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa							
71	H71D	CAT	C	His	H	211	G	GAT	Asp	D	1	R	3			McCammom M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico							
71	H71D	CAT	C	His	H	211	G	GAT	Asp	D	8	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand							
71	H71N	CAT	C	His	H	211	A	AAT	Asn	N	1	R	4			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe							
71	H71N	CAT	C	His	H	211	A	AAT	Asn	N	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium							
71	H71R	CAT	A	His	H	212	G	CGT	Arg	R	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA							
71	H71R	CAT	A	His	H	212	G	CGT	Arg	R	3	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal							
71	H71R	CAT	A	His	H	212	G	CGT	Arg	R	3	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa							
71	H71R	CAT	A	His	H	212	G	CGT	Arg	R	1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea							
71	H71R	CAT	A	His	H	212	G	CGT	Arg	R	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC							
71	H71R	CAT	A	His	H	212	G	CGT	Arg	R	3	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland							
71	H71P	CAT	A	His	H	212	C	CCT	Pro	P	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan							
71	H71Q	CAT	T	His	H	212	G	CAG	Gln	Q	1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA							
71	H71Q	CAT	T	His	H	213	A	CAA	Gln	Q	2	R	4			Simons S.O. J. Clin. Microb. 12	Netherlands							
71	Frameshift	CAT	del	His	H	213	T				1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil							
72	C72R	TGC	T	Cys	C	214	C	CGC	Arg	R	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Japan							
72	C72R	TGC	T	Cys	C	214	C	CGC	Arg	R	2	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA							
72	C72R	microarray	TGC	T	Cys	C	214	C	CGC	Arg	R	2	R	3		Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA							
72	C72R	TGC	T	Cys	C	214	C	CGC	Arg	R	1	R	1	negative	1	Bhuju S. Infection, Genetics and Evolution 13	Brazil							
72	C72Y	TGC	G	Cys	C	215	A	TAC	Tyr	Y	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa							
72	C72Y	TGC	G	Cys	C	215	A	TAC	Tyr	Y	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand							
72	C72Y	TGC	G	Cys	C	215	A	TAC	Tyr	Y	1	R	1	negative	1	Bhuju S. Infection, Genetics and Evolution 13	Brazil							
72	Frameshift	TGC	ins			215	ins 29bp				1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France							
72	C72W	TGC	C	Cys	C	216	G	TGG	Trp	W	2	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia							
72	C72W	TGC	C	Cys	C	216	G	TGG	Trp	W	2	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan							
72	C72STOP	TGC	C	Cys	C	216	A	TGG	Trp	W	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea							
73	Frameshift	GTC	ins	Val	V	218	CGC ATT GCC G				1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan							
74	Frameshift	AGC	ins	Ser		221	G				2	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	UK							
75	G75R	GGT	G	Gly	G	222	C	CGT	Arg	R	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Myanmar							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	2	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	5	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	3			McCammom M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	2	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	4	R	4			Simons S.O. J. Clin. Microb. 12	Netherlands							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	4	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	1	negative	1	Bhuju S. Infection, Genetics and Evolution 13	Brazil							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	1	R	4			Tan Y. J. Clin. Microb. 14	China							
76	T76P	ACT	A	Thr	T	226	C	CCT	Pro	P	6	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland							
76	T67I	ACT	C	Thr	T	227	T	ATT	Ile	I	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea							
76	T67I	ACT	C	Thr	T	227	T	ATT	Ile	I	1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01/14	Korea							

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position			Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates			
			codon	nucleotide	AA	AA	Nucleotide substitution	AA substitution		AA	AA	Phenotype: S sensitive; R resistant	Method : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960			Pyrazinamidase activity	Method : 1 Wayne 2 other test	
																		AA
AA position	AA substitution																	
76	T67I		ACT	C	Thr	T	227	T	ATT	Ile	I	1	R	3	positive	1	Brown T.J. J. Med. Microbiol. 00	Turkey/UK
76	T67I		ACT	C	Thr	T	227	T	ATT	Ile	I	1	R	1	negative	1	Bhuju S. Infection, Genetics and Evolution 13	Brazil
77	Frameshift		CCC	ins	Pro	P	230-231	IS6110				1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
77	Frameshift		CCC	ins				G				2	R	3				
78	G78C		GGC	G	Gly	G	232	T	TGC	Cys	C	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
78	G78C		GGC	G	Gly	G	232	T	TGC	Cys	C	1	R	3			Sheen P. J. Clin. Microbiol.09	Peru
78	G78V	microarray	GGC	G	Gly	G	233	T	GTC	Val	V	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
78	G78D		GGC	G	Gly	G	233	A	GAC	Asp	D	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
78	G78D		GGC	G	Gly	G	233	A	GAC	Asp	D	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
78	Frameshift		GGC	ins	Gly	G	234	G				1	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
78	Frameshift	microarray	GGC	ins	Gly	G	234	G				1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
79	A79V, Frameshift		GCG	C	Ala	A	236	T	GTG	Val	V	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
				ins			360	T				1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
80	missense 80-118		GAC	A	Asp	D	239	del 80-118				1	R	3	negative	1	Brown T.J. J. Med. Microbiol. 00	Turkey/UK
81	F81V		TTC	T	Phe	F	241	G	GTC	Val	V	1	R	3			Sachais B. S. Molecular Diag. 98	USA
81	F81V		TTC	T	Phe	F	241	G	GTC	Val	V	1	R	4			Tan Y. J. Clin. Microb. 14	China
82	H82Y		CAT	C	His	H	244	T	TAT	Tyr	Y	1	R	3	negative	1	Brown T.J. J. Med. Microbiol. 00	Turkey/UK
65	S65S		TCC	C	Ser	S	194	G	TCG	Ser	S	1	R	3				
82	H82D		CAT	C	His	H	244	A	AAT	Asp	D	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
82	H82R		CAT	A	His	H	245	G	CGT	Arg	R	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
82	H82R	microarray	CAT	A	His	H	245	G	CGT	Arg	R	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
82	H82R		CAT	A	His	H	245	G	CGT	Arg	R	1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
82	H82L		CAT	A	His	H	245	T	CTT	Leu	L	1	R	1				Brazil
82	H82R		CAT	A	His	H	245	G	CGT	Arg	R	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
82	H82R		CAT	AT	His	H	245-246	GG	CGG	Arg	R	1	R	4			Tan Y. J. Clin. Microb. 14	China
83	no published mutation		CCC		Pro	P												
84	Frameshift		AGT	ins			250	C				4	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
85	L85P		CTG	T	Leu	L	254	C	CCG	Pro	P	13	R	3			Somoskovi A. J. Clin. Microb. 07	USA
85	L85P	microarray	CTG	T	Leu	L	254	C	CCG	Pro	P	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
85	L85P	microarray	CTG	T	Leu	L	254	C	CCG	Pro	P	3	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
85	L85P	microarray	CTG	T	Leu	L	254	C	CCG	Pro	P	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
85	L85P		CTG	T	Leu	L	254	C	CCG	Pro	P	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
85	L85P		CTG	T	Leu	L	254	C	CCG	Pro	P	8	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
85	L85P		CTG	T	Leu	L	254	C	CCG	Pro	P	3	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
85	L85P		CTG	T	Leu	L	254	C	CCG	Pro	P	2	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
85	L85R		CTG	T	Leu	L	254	G	CGG	Arg	R	2	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia
85	L85R		CTG	T	Leu	L	254	G	CGG	Arg	R	1	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
85	L85R		CTG	T	Leu	L	254	G	CGG	Arg	R	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
85	L85R		CTG	T	Leu	L	254	G	CGG	Arg	R	1	R	1	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
85	L85R		CTG	T	Leu	L	254	G	CGG	Arg	R	1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Azerbaijan
86	no published missense-mutation		GAC		Asp	D												
86	Frameshift		GAC	ins	Asp	D		18 bp				1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
87	T87M		ACG	C	Thr	T	260	T	ATG	Met	M	1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
87	Frameshift			del			436	G										
87	T87M		ACG	C	Thr	T	260	T	ATG	Met	M	2	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
87	Frameshift		ACG	ins	Thr	T	260/261	AC	ACACG			1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
88	S88STOP		TCG	C	Ser	S	263	A	TAG	STOP		1	R	1,3			Hou L. Epidemiol. Infect. 00	China
89	Frameshift		GCA	del	Ala	A	265	del 24 bp				1	R	3			Hannan M. M. J. Clin. Microb. 01	USA
90	I90S		ATC	T	Ile	I	269	G	AGC	Ser	S	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain		wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
			codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive; R resistant	Method: 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test		
AA position	AA substitution																	
90	I90S		ATC	T	Ile	I	270	G	AGC	Ser	S	1	R	3			Hannan M. M. J. Clin. Microb. 01	USA
90	I90S		ATC	T	Ile	I	269	G	AGC	Ser	S	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
90	I90S	microarray	ATC	T	Ile	I	269	G	AGC	Ser	S	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
91	E91STOP		GAG	G	Glu	E	271	T	TAG	STOP	Z	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
91	E91STOP		GAG	G	Glu	E	271	T	TAG	STOP	Z	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
91	E91del		GAG	G	Glu	E						1	R	4			Tan Y. J. Clin. Microb. 14	China
92	no published mutation		GCG		Ala	A												
93	V93L		GTG	G	Val	V	277	C	CTG	Leu	L	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
93	Frameshift		GTG	ins	Val	V	279	106 bp				1	R	1			Sheen P. J. Clin. Microbiol. 09	Peru
94	F94L		TTC	T	Phe	F	280	C	CTC	Leu	L	2	R	3	negative	1	Sheen P. J. Clin. Microbiol. 09	Peru
94	F94L		TTC	T	Phe	F	280	C	CTC	Leu	L	1	R	4			Tan Y. J. Clin. Microb. 14	China
94	F94L		TTC	T	Phe	F	280	C	CTC	Leu	L	8	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
94	F94P		TTC	TT	Phe	F	280-281	CC	TCC	Pro	P	2	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
94	F94S	point towards the active-site region	TTC	T	Phe	F	281	C	TCC	Ser	S	1	R	4			Huang T.S. Antimicrob. Agents Chemother. 03	Taiwan
94	F94S		TTC	T	Phe	F	281	C	TCC	Ser	S	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
94	F94S		TTC	T	Phe	F	281	C	TCC	Ser	S	1	R	4			Tan Y. J. Clin. Microb. 14	China
94	F94S		TTC	T	Phe	F	281	C	TCC	Ser	S	3	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
94	F94C		TTC	T	Phe	F	281	C	TGC	Ser	S	6	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
94	F94L		TTC	T	Phe	F	282	C	TTA	Leu	L	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
94	F94L		TTC	T	Phe	F	282	C	TTG	Leu	L	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
94	Frameshift		TTC	del	Phe	F	282	C				1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
95	Frameshift		TAC	del	Tyr	Y	285	CA				2	R	3			Sheen P. J. Clin. Microbiol. 09	Peru
95	Y95STOP	microarray	TAC	C	Tyr	Y	285	A	TAA	STOP		1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
95	Y95STOP	microarray	TAC	C	Tyr	Y	285	A	TAA	STOP		1	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal
95	Y95STOP		TAC	C	Tyr	Y	285	G	TAG	STOP		1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	K96Q		AAG	A	Lys	K	286	C	CAG	Gln	Q	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
96	K96Q		AAG	A	Lys	K	286	C	CAG	Gln	Q	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	K96E		AAG	A	Lys	K	286	G	GAG	Glu	E	3	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
96	K96E		AAG	A	Lys	K	286	G	GAG	Glu	E	3	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain		wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
			codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive; R resistant	Méthod : 1 Proportions; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Méthod : 1 Wayne 2 other test		
96	K96E		AAG	A	Lys	K	286	G	GAG	Glu	E	3	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
96	K96E		AAG	A	Lys	K	286	G	GAG	Glu	E	1	R				Tan Y. J. Clin. Microb. 14	China
96	K96E		AAG	A	Lys	K	286	G	GAG	Glu	E	6	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	K96E		AAG	A	Lys	K	286	G	GAG	Glu	E	1	S	3			Feuerrigel S. BMC Microbiology 2012	Germany
96	K96M		AAG	A	Lys	K	286	T	ATG	Met	M	1	R	4			Piersimoni C J Clin Microb 13	Italy
96	K96STOP		AAG	A	Lys	K	286	T	TAG	STOP		1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
96	K96T		AAG	A	Lys	K	286	C	ACG	Thr	T	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
96	K96T		AAG	A	Lys	K	286	C	ACG	Thr	T	1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
96	K96T		AAG	A	Lys	K	286	C	ACG	Thr	T	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
96	K96T		AAG	A	Lys	K	286	C	ACG	Thr	T	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	K96R		AAG	A	Lys	K	286	G	AGG	Arg	R	4	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
96	K96R		AAG	A	Lys	K	286	G	AGG	Arg	R	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	K96N		AAG	G	Lys	K	287	T	AAT	Asn	N	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
96	K96N		AAG	G	Lys	K	287	T	AAC	Asn	N	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	Frameshift		AAG	ins	Lys	K	287	T				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
96	Frameshift		AAG	ins	Lys	K	287	T	AATG			1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Canada
96	Frameshift		AAG	ins	Lys	K	288	T				2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	Frameshift		AAG	ins	Lys	K	288	33 nt				4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
96	Frameshift		GGT	del	Lys	K	288	G				1	R	1	negative	1	Scorpio A. Nature 96	USA
96	Frameshift	microarray	GGT	del	Lys	K	288	G				1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
97	G97C		GGT	G	Gly	G	289	T	TGT	Cys	C	2	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
97	G97C		GGT	G	Gly	G	289	T	TGT	Cys	C	2	R	4			Piersimoni C J Clin Microb 13	Italy
97	G97S		GGT	G	Gly	G	289	A	AGT	Ser	S	2	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
97	G97S		GGT	G	Gly	G	289	A	AGT	Ser	S	2	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
97	G97S	microarray	GGT	G	Gly	G	289	A	AGT	Ser	S	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
97	G97S		GGT	G	Gly	G	289	A	AGT	Ser	S	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
97	G97S		GGT	G	Gly	G	289	A	AGT	Ser	S	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
97	G97S		GGT	G	Gly	G	289	A	AGT	Ser	S	3	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
97	G97S		GGT	G	Gly	G	289	A	AGT	Ser	S	6	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
97	G97R		GGT	G	Gly	G	289	C	CGT	Arg	D	1	R	4			Simons S.O. J. Clin. Microb. 12	Netherlands
97	G97D		GGT	G	Gly	G	290	A	GAT	Asp	D	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
97	G97D		GGT	G	Gly	G	290	A	GAT	Asp	D	1	R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore
97	G97D		GGT	G	Gly	G	290	A	GAT	Asp	D	1	R	4			Huang T.S. Antimicrob. Agents Chemother. 03	Taiwan

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

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				codon	nucleotide	AA		AA	AA	Phenotype: S sensitive ; R resistant	Méthod : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960			Pyrazinamidase activity	Method : 1 Wayne 2 other test			
AA position	AA substitution																	
97	G97D		GGT	G	Gly	G	290	A	GAT	Asp	D	1	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe
97	G97D		GGT	G	Gly	G	290	A	GAT	Asp	D	1	R	3	1neg, 1pos	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
97	G97D		GGT	G	Gly	G	290	A	GAT	Asp	D	4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
97	G97D		GGT	G	Gly	G	290	A	GAT	Asp	D	1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
97	G97D		GGT	G	Gly	G	290	C	GCT	Asp	D	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden
97	G97D		GGT	G	Gly	G	290	C	GCT	Asp	D	4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
97	G97A		GGT	G	Gly	G	290	C	GCT	Ala	A	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
97	Frameshift		GGT	ins	Lys	K	290	T	GGTT			1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
97	Frameshift		GGT	del	Gly	G	290	T				1	R	4			Piersimoni C J Clin Microb 13	Italy
97	Frameshift		GGT	del			291	T				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
98	no published missense-mutation		GCC		Ala	A												
98	Frameshift		GCC	ins	Ala	A	292	G				1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
98	Frameshift		GCC	del	Ala	A	293	10 bp				1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
99	Y99STOP		TAC	C	Tyr	Y	297	G	TAG	STOP	Z	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
99	Y99STOP		TAC	C	Tyr	Y	297	G	TAG	STOP	Z	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
99	Y99STOP		TAC	C	Tyr	Y	297	A	TAA	STOP	Z	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand
99	Y99STOP		TAC	C	Tyr	Y	297	A	TAA	STOP	Z	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
99	Y99STOP		TAC	C	Tyr	Y	297	A	TAA	STOP	Z	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
100	Frameshift		ACC	del	Thr	T		C				1	R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore
100	T100P		ACC		Thr	T	298	A	CCC	Pro	P	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
100	T100A		ACC		Thr	T	298	A	GCC	Ala	A	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
101	Frameshift		GGA	del	Gly	G	301	G	GA			1	R	1,3			Hou L. Epidemiol. Infect. 00	China
101	Frameshift		GGA	del	Gly	G	301	G	GA			1	R	1	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
102	A102V		GCG	G	Ala	A	304	A	ACG	Thr	T	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
102	A102V		GCG	C	Ala	A	305	T	GTG	Val	V	2	R	3	1neg, 1pos	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
102	A102V		GCG	C	Ala	A	305	T	GTG	Val	V	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
102	A102V		GCG	C	Ala	A	305	T	GTG	Val	V	1	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe
102	A102V		GCG	C	Ala	A	305	T	GTG	Val	V	1	R	4			Daum L. J Clin Microbiol 12	Texas
102	Frameshift		GCG	ins	Ala	A	306	C				1	R	3	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
103	Y103H		TAC	T	Tyr	Y	307	C	CAC	His	H	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
103	Y103H		TAC	T	Tyr	Y	307	C	CAC	His	H	5	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt											Nucleotide position	Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
		codon	nucleotide	AA	AA	Nucleotide substitution	AA	AA	Phenotype: S sensitive; R resistant	Method: 1 Proportion s; 2 Rapid broths; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test											
														AA	AA	AA							
103	Y103H	TAC	T	Tyr	Y	307	C	CAC	His	H	1 (mixed)	R	1			McCammom M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico						
103	Y103H	TAC	T	Tyr	Y	307	C	CAC	His	H	2	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea						
103	Y103H	TAC	T	Tyr	Y	307	C	CAC	His	H	1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Canada						
103	Y103D	TAC	T	Tyr	Y	307	G	GAC	Asp	D	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA						
103	Y103D	TAC	T	Tyr	Y	307	G	GAC	Asp	D	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Germany						
103	Frameshift	TAC	del			307-311	del TAC AG				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea						
103	Y103C	TAC	A	Tyr	Y	308	G	TGC	Cys	C	1	R	3	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France						
103	Y103C	TAC	A	Tyr	Y	308	G	TGC	Cys	C	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland						
103	Y103S	TAC	A	Tyr	Y	308	C	TCC	Ser	S	1	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia						
103	Y103S	TAC	A	Tyr	Y	308	C	TCC	Ser	S	2	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea						
103	Y103OCH	TAC	C	Tyr	Y		A	TAA	OCH	Z	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC						
103	Y103STOP	TAC	C	Tyr	Y	309	G	TAG	STOP	Z	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea						
103	Y103STOP	TAC	C	Tyr	Y	309	G	TAG	STOP	Z	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia						
103	Y103STOP	TAC	C	Tyr	Y	309	G	TAG	STOP	Z	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil						
103	Y103STOP	TAC	C	Tyr	Y	309	G	TAG	STOP	Z	2	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa						
103	Y103STOP	TAC	C	Tyr	Y	309	G	TAG	STOP	Z	1	R	1			McCammom M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico						
103	Y103STOP	TAC	C	Tyr	Y	309	G	TAG	AMB	Z	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC						
103	Y103STOP	TAC	C	Tyr	Y	309	G	TAG	STOP	Z	9	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru						
104	S104C	AGC	A	Ser	S	310	G	TGC	Cys	C	1	R	3			Hannan M. M. J. Clin. Microb. 01	USA						
104	S104R	AGC	C	Ser	S	312	G	AGG	Arg	R	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Yemen						
104	S104R	AGC	C	Ser	S	312	G	AGG	Arg	R	3	R	3			Somoskovi A. J. Clin. Microb. 07	USA						
104	S104R	AGC	C	Ser	S	312	G	AGG	Arg	R	2	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand						
105	G105D	GGC	G	Gly	G	314	A	GAC	Asp	D	2	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil						
105	G105D	GGC	G	Gly	G	314	A	GAC	Asp	D	2	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru						
105	Frameshift	GGC	ins	Gly	G	314	C				1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil						
105	Frameshift	GGC	ins			315	G				2	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil						
105	Frameshift	GGC	ins	Gly	G	315	G				1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa						
105	Frameshift	GGC	del			316	245-bp CT				1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland						
106	Frameshift	TTC	ins	Phe	F	317					1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea						
107	E107K	GAA	G	Glu	E	319	A	AAA	Lys	K	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa						
108	G108R	GGA	G	Gly	G	322	C	CGA	Arg	R	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA						
108	G108R	GGA	G	Gly	G	322	C	CGA	Arg	R	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil						
108	G108R	GGA	G	Gly	G	322	C	CGA	Arg	R	2	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea						
109	no published mutation	GTC		Val	V																		
110	no published mutation	GAC		Asp	D																		
111	K111Q	GAG	G	Lys	K	331	C	CAG	Gln	Q	1	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe						
112	no published mutation	AAC		Asn	N																		
113	no published mutation	GGC		Gly	G																		
114	T114P	ACG	A	Thr	T	340	C	CCG	Pro	P	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Yemen						
114	T114P	ACG	A	Thr	T	340	C	CCG	Pro	P	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa						
114	T114P	ACG	A	Thr	T	340	C	CCG	Pro	P	2	R				Napiorkowska A The Int J Tub Lung Dis 2014	Poland						
114	T114M	polymorphism	ACG	C	Thr	T	341	T	ATG	Met	M	10	S	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa					
114	Frameshift	ACG	del	Thr	T	341	C				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea						
114	Frameshift	ACG	del	Thr	T	341	C				1	R	1	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea						
114	Frameshift	ACG	ins	Thr	T	341	ins 1355bp				1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France						
114	IS6110 Frameshift	ACG	ins	Thr	T						1	R	1			McCammom M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico						
115	no published mutation	CCA		Pro	P																		

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt											Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
		codon	nucleotide	AA	AA	Nucleotide substitution	AA substitution	AA	AA	Phenotype: S sensitive ; R resistant	Method : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity		Method : 1 Wayne 2 other test										
															Phenotype	Method	Pyrazinamidase		Method					
116	L116V	CTG	C	Leu	L	346	G	GTG	Val	V	1	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa							
116	L116P	CTG	T	Leu	L	347	C	CCG	Pro	P	1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru							
116	L116P	CTG	T	Leu	L	347	C	CCG	Pro	P	1	R	4			Piersimoni C J Clin Microb 13	Italy							
116	L116R	CTG	T	Leu	L	347	G	CGG	Arg	R	2	R	3			Somoskovi A. J. Clin. Microb. 07	USA							
116	L116R	CTG	T	Leu	L	347	G	CGG	Arg	R	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia							
116	L116R	CTG	T	Leu	L	347	G	CGG	Arg	R	8	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland							
117	Frameshift	CTG	ins	Leu	L	350/351	T	CTTG			1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan							
118	Frameshift	AAT	del	Asn	N	352-358	del 5bp				1	R	4			Huang T.S. Antimicrob. Agents Chemother. 03	Taiwan							
118	N118T	AAT	A	Asn	N	353	C	ACT	Thr	T	1	R	1,3			Hou L. Epidemiol. Infect. 00	China							
119	W119R	TGG	T	Trp	W	355	C	CGG	Arg	R	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA							
119	W119R	TGG	T	Trp	W	355	A	AGG	Arg	R	2	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe							
119	W119L	TGG	G	Trp	W	356	T	TTG	Leu	L	1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru							
119	W119C	TGG	G	Trp	W	357	T	TGT	Cys	C	2	R	3			Somoskovi A. J. Clin. Microb. 07	USA							
119	W119STOP	TGG	G	Trp	W	357	A	TGA	STOP	Z	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea							
120	L120P	CTG	T	Leu	L	359	C	CCG	Pro	P	13	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal							
120	L120P	CTG	T	Leu	L	359	C	CCG	Pro	P	2	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe							
121	L120P	CTG	T	Leu	L	359	C	CCG	Pro	P	4	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden							
120	L120R	CTG	T	Leu	L	359	G	CGG	Arg	R	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil							
120	L120R	CTG	T	Leu	L	359	G	CGG	Arg	R	7	R	3,4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico							
120	Frameshift	CTG	del	Leu	L	359	81 bp				2	R	3	negative	2	Sheen P. J. Clin. Microbiol.09	Peru							
121	R121P	CGG	G	Arg	R	362	C	CCG	Pro	P	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea							
121	R121P	CGG	G	Arg	R	362	C	CCG	Pro	P	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA							
122	Q122STOP	CAA	C	Gln	Q	364	T	TAA	STOP			R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru							
122	Q122STOP	CAA	C	Gln	Q	364	T	TAA	STOP			R	4			Daum L. J Clin Microbiol 12	Texas							
122	Q122 del	CAA	del	Gln	Q						1	R	4			Tan Y. J. Clin. Microb. 14	China							
122	Q122L	CAA	C	Gln	Q	365	T	CTA	Leu	L	1	R	3			Lily Therese K. 12	India							
123	Frameshift		ins			368	ins 18bp				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea							
123	Frameshift	CGC	ins	Arg	R		AG				1	R	1,3			Hou L. Epidemiol. Infect. 00	China							
123	R123P	CGC	G	Arg	R	368	C	CCC	Pro	P	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden							
123	R123P	CGC	G	Arg	R	368	C	CCC	Pro	P	1	R	3			Wengren J. Antimicro. Agents Chemother. 11	Sweden							
123	R123P	CGC	G	Arg	R	368	C	CCC	Pro	P	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden							
124	G124D	GGC	G	Gly	G	371	A	GAC	Asp	D	1	S	4			Simons S.O. J. Clin. Microb. 12	Netherlands							
125	V125F	GTC	G	Val	V	373	T	TTC	Phe	F	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden							
125	V125F	GTC	G	Val	V	373	T	TTC	Phe	F	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico							
125	V125F	GTC	G	Val	V	373	T	TTC	Phe	F	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand							
125	V125F	GTC	G	Val	V				Phe	F	1	R	3			Wengren J. Antimicro. Agents Chemother. 11	Sweden							
126	V125F	GTC	G	Val	V	373	T	TTC	Phe	F	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico							
125	V125D	GTC	T	Val	V	374	A	GAC	Asp	D	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia							
125	V125D	GTC	T	Val	V	374	A	GAC	Asp	D	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden							
125	V125G	GTC	T	Val	V	374	G	GGC	Gly	G	8	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal							
125	V125G	GTC	T	Val	V	374	G	GGC	Gly	G	11	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal							
126	no published missense-mutation	GAT		Asp	D																			
126	Frameshift	GAT	ins	Asp	D	377	GA				1	R	3	negative	1									
127	Frameshift	GAG	del	Glu	E	379-389	del 11bp				1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia							
127	E127STOP	GAG	G	Glu	E	379	T	TAG	STOP		1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand							
127	Frameshift	GAG	del	Glu	E	381-382	GG				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea							
127	Frameshift	GAG	del	Glu	E	381	del 19 bp				1	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal							

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain		wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
			codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive ; R resistant	Method : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method : 1 Wayne 2 other test		
128	Frameshift		GTC	ins	Val	V	382	AG				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
128	Frameshift		GTC	ins	Val	V	382	AG				1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea
128	V128G		GTC	T	Val	V	383	G	GGC	Gly	G	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
128	V128G		GTC	T	Val	V	383	G	GGC	Gly	G	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
128	V128G		GTC	T	Val	V	383	G	GGC	Gly	G	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
128	V128G		GTC	T	Val	V	383	G	GGC	Gly	G	1	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe
129	V128G		GTC	T	Val	V	383	G	GGC	Gly	G	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden
128	Frameshift	microarray	GTC	del	Val	V	383	del GTG GAT GTG		ins Glu Val Asp		1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
128-129-130				del								1	R	1			Somoskovi A. J. Clin. Microb. 07	USA
129	Frameshift		GAT	ins	Asp	D	385/386	CG				1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
129-130	Frameshift			del			386-388	del ATG				1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
129-130	Frameshift			del			386-389	del ATG T				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
129-130	Frameshift			del			386-394					1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
130	Frameshift		GTG	ins	Val	V	388	AGG TCG ATG		ins Arg Ser Met		4	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
130	V130-E-V-D ins.		GTG	ins	Val	V	388	GAG GTC GAT				1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
130	V130G		GTG	T	Val	V	389	G	GGG	Gly	G	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
130	V130G		GTG	T	Val	V	389	G	GGG	Gly	G	2	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Canada
130	V130G		GTG	T	Val	V	389	G	GGG	Gly	G	1	R	3	negative	2	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
130	Frameshift			ins			420	GG									Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
130	V130G		GTG	T	Val	V	389	G	GGG	Gly	G	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
130	V130A		GTG	T	Val	V	389	C	GCG	Ala	A	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
130	V130A		GTG	T	Val	V	389	C	GCG	Ala	A	1	R	1		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
130	Frameshift		GTG	ins	Val	V		GG				1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
130	Frameshift		GTG	ins	Val	V	389	GG				9	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
130-132	VVD130-132 del			del			389-396					1	R	4			Tan Y. J. Clin. Microb. 14	China
131	V131 del		GTC	del	Val	V						1	R	4			Tan Y. J. Clin. Microb. 14	China
131	V131F		GTC	G	Val	V	391	T	TTC	Phe	F	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
131	Frameshift		GTC	del	Val	V	391	G				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
131	Frameshift		GTC	ins	Val	V	391	G				1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
131	Frameshift		GTC	ins	Val	V	391	GG				1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
131	Frameshift		GTC	ins	Val	V	391	GG				1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
131	Frameshift		GTC	ins	Val	V	391	GG				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
131	Frameshift		GTC	ins	Val	V	391	GG				1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
131	Frameshift		GTC	ins	Val	V	391	GG				2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain		wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
			codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive; R resistant	Method: 1 Proportions; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test		
AA position	AA substitution																	
131	Frameshift		GTC	ins	Val	V	391	G				3	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
131	Frameshift		GTC	ins	Val	V	392	G				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
131	Frameshift		GTC	ins	Val	V	391/392	GG				1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
131	Frameshift	microarray	GTC	ins	Val	V	392	GG					R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
131	Frameshift		GTC	ins	Val	V	392	GG				4	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
131	Frameshift		GTC	ins	Val	V	392	G				1	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal
131	Frameshift		GTC	ins	Val	V	392	G				2	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
131	Frameshift		GTC	ins	Val	V	393	GT				1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea
131	Frameshift		GTC	ins	Val	V	393	T				1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea
131	Frameshift		GTC	ins	Val	V	393	G				2	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
131	Frameshift		GTC	ins	Val	V	393	GG				1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
132	G132S		GGT	G	Gly	G	394	A	AGT	Ser	S	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
132	G132S		GGT	G	Gly	G	394	A	AGT	Ser	S	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
132	G132S		GGT	G	Gly	G	394	A	AGT	Ser	S	2	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
132	G132S		GGT	G	Gly	G	394	A	AGT	Ser	S	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
132	G132S	microarray	GGT	G	Gly	G	394	A	AGT	Ser	S	2	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
132	G132S		GGT	G	Gly	G				Ser	S	1	R	3			Werngren J. Antimicrob. Agents Chemother. 11	Sweden
132	G132S		GGT	G	Gly	G	394	A	AGT	Ser	S	1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
132	G132C		GGT	G	Gly	G	394	A	TGT	Cys	S	2	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
132	Frameshift		GGT	ins	Gly	G	394	ATG TGG TCG				1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
132	Frameshift		GGT	ins	Gly	G	394	GGT GC				1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
132	G132D		GGT	G	Gly	G	395	A	GAT	Asp	D	1	R	3	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
132	G132D		GGT	G	Gly	G	395	A	GAT	Asp	D	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Myanmar
132	G132D		GGT	G	Gly	G	395	A	GAT	Asp	D	2	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt											Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
		codon	nucleotide	AA	AA	Nucleotide substitution	AA substitution	AA	AA	Phenotype: S sensitive; R resistant	Method : 1 Proportions; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity		Method : 1 Wayne 2 other test										
															Phenotype	Method	Pyrazinamidase		Method					
AA position	AA substitution																							
132	G132D	GGT	G	Gly	G	395	A	GAT	Asp	D	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden							
132	G132A	GGT	G	Gly	G	395	C	GCT	Ala	A	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden							
132	G132A	GGT	G	Gly	G	395	C	GCT	Ala	A	1	R	3			Werngren J. Antimicrob. Agents Chemother. 11	Sweden							
132	G132A	GGT	G	Gly	G	395	C	GCT	Ala	A	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden							
132	G132A	GGT	G	Gly	G	395	C	GCT	Ala	A	1	R	4			Tan Y. J. Clin. Microb. 14	China							
132	G132A	GGT	G	Gly	G	395	C	GCT	Ala	A	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden							
132-137	G132V	GGT	G	Gly	G	395	T	GTT	Val	V	2	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea							
133	Frameshift	GGT	del			395-411	del				1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Inde							
133	Frameshift	ATT	ins			397	T				1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA							
133-187	Frameshift		del				163 bp					R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore							
133	Frameshift	ATT	ins			397	G				1	R	4			Huang T.S. Antimicrob. Agents Chemother. 03	Taiwan							
133	I133T	ATT	T	Ile	I	398	C	ACT	Thr	T	1	R	3	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France							
133	I133T	ATT	T	Ile	I	398	C	ACT	Thr	T	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia							
133	I133T	ATT	T	Ile	I	398	C	ACT	Thr	T	17	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden							
133	I133N	ATT	T	Ile	I	398	A	AAT	Asn	N	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC							
133	I133S	ATT	T	Ile	I	398	G	AGT	Ser	S	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil							
133	I133T	ATT	T	Ile	I	398	C	ACT	Thr	T	2	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan							
133	I133T	ATT	T	Ile	I	398	C	AGT	Thr	T	1	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal							
133	Frameshift	ATT	ins	Ile	I	398	ins T				1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden							
134	A134V	GCC	C	Ala	A	401	T	GTC	Val	V	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru							
134	A134V	GCC	C	Ala	A	401	T	GTC	Val	V	1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	Canada							
134	A134V	GCC	C	Ala	A	401	T	GTC	Val	V	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC							
134	A134V	GCC	C	Ala	A	401	T	GTC	Val	V	1	R	4			Huang T.S. Antimicrob. Agents Chemother. 03	Taiwan							
134	A134V	microarray	GCC	C	Ala	A	401	T	GTC	Val	V	1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA						
134	A134V	GCC	C	Ala	A	401	T	GTC	Val	V	2	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USA/Texas/Mexico							
134	A134V	GCC	C	Ala	A	401	T	GTC	Val	V	2	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden							
135	Frameshift	ACC	ins			403	C				1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA							
135	Frameshift	GCC	ins	Ala	A	403	CC				1	R	1,3			Hou L. Epidemiol. Infect. 00	China							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	2	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	6	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	1	R	4			Tan Y. J. Clin. Microb. 14	China							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	4	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden							

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt										Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates
		codon	nucleotide	AA	AA	Nucleotide substitution	AA substitution	AA	AA	Phenotype: S sensitive; R resistant	Method : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960		Pyrazinamidase activity	Method : 1 Wayne 2 other test									
															AA	AA							
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	2	R					Yoon JH World J Microbiol Biotechnol 14	Korea					
135	T135P	ACC	A	Thr	T	403	C	CCC	Pro	P	4	R	4		2		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden					
135	T135P	ACC	A	Thr	A	403	C	CCC	Pro	P	1	R	3				Napiorkowska A The Int J Tub Lung Dis 2014	Poland					
135	T135N	ACC	C	Thr	A	404	A	AAC	Asn	N	3	R	3				Napiorkowska A The Int J Tub Lung Dis 2014	Poland					
135	T135N	ACC	C	Thr	T	404	A	AAC	Asn	N	3	R	4		2		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden					
136	D136H	GAT	G	Asp	D	406	C	CAT	His	H	1	R	4				Portugal I. Antimicrob Agents Chemother 04	Portugal					
136	D136H	GAT	G	Asp	D	406	C	CAT	His	H	1	R	3	negative	1		Mestdagh M. Antimicrob. Agents Chemother. 99	Scotland					
136	D136Y	GAT	G	Asp	D	406	T	TAT	Tyr	Y	1	R	2				Sekiguchi J.I. J. Clin. Microb. 07	Japan					
136	D136Y	GAT	G	Asp	D	406	T	TAT	Tyr	Y	1	R		negative	1		Lee K.W. J Korean Med Sci 01	South Korea					
136	D136Y	GAT	G	Asp	D	406	T	TAT	Tyr	Y	3	R	4		2		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden					
136	D136N	GAT	G	Asp	D	406	A	AAT	Asn	N	2	R		negative	1		Lee K.W. J Korean Med Sci 01	South Korea					
136	D136N	GAT	G	Asp	D	406	A	AAT	Asn	N	1	R	3				Clemente W.T. Diag. Microbiol. Infect. Dis. 08	Brazil					
136	Frameshift	GAT	del	Asp	D	406	G				1	R		negative	1		Lee K.W. J Korean Med Sci 01	South Korea					
136	D136G	GAT	A	Asp	D	407	G	GGT	Gly	G	1	R	4				Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa					
136	D136G	GAT	A	Asp	D	407	G	GGT	Gly	G	1	R	1	negative	2		Park S.K. BMC Infect. Dis. 01	Korea					
136	D136G	GAT	A	Asp	D	407	G	GGT	Gly	G	1	R	1	negative	1		Sheen P. J. Clin. Microbiol.09	Peru					
136	D136G	GAT	A	Asp	D	407	G	GGT	Gly	G	1	R	4				Tan Y. J. Clin. Microb. 14	China					
136	D136G	GAT	A	Asp	D	407	G	GGT	Gly	G	1	R	1				Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea					
136	Frameshift	GAT	ins	Asp	D	408	C				1	R	3	negative	1		Mestdagh M. Antimicrob. Agents Chemother. 99	Azerbaijan					
136	Frameshift	GAT	ins	Asp	D	408	GC				1	R	1	negative	1		Suzuki Y. J. Clin. Microb. 02	Japan					
136	Frameshift	GAT	ins	Asp	D	408	A				4	R	4		2		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden					
137	H137D	CAT	A	His	H	409	G	GAT	Asp	D	1	R	4		2		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden					
137	H137R	CAT	A	His	H	410	G	CGT	Arg	R	2	R	1 ou 3				Sreevatsan S. Antimicrob. Agents Chemother. 97	USA					
137	H137R	CAT	A	His	H	410	G	CGT	Arg	R	2	R	1	negative	1		Morlock G.P. Antimicrob. Agents Chemother. 00	CDC					
137	H137R	CAT	A	His	H	410	G	CGT	Arg	R	1	R	4		2		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden					
137	H137P	CAT	A	His	H	410	C	CCT	Pro	P	1	R		negative	1		Lee K.W. J Korean Med Sci 01	South Korea					
137	H137P	CAT	A	His	H	410	C	CCT	Pro	P	1	R	3	negative	1		Mestdagh M. Antimicrob. Agents Chemother. 99	Bangladesh					
137	H137P	CAT	A	His	H	410	C	CCT	Pro	P	1	R	3	negative	1		Scorpio A. Antimicrob. Agents Chemother. 97	USA					
137	H137P	CAT	A	His	H	410	C	CCT	Pro	P	1	R	3	negative	1		Sheen P. J. Clin. Microbiol.09	Peru					
137	H137P	CAT	A	His	H	410	C	CCT	Pro	P	1	R	4		2		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden					
137	Frameshift		ins			411/412	b/w				1	R	1	negative	1		Jonmalung J. BMC Microbiology 10	Thailand					
138	C138R	TGT	T	Cys	C	412	C	CGT	Arg	R	1	R	1	negative	1		Suzuki Y. J. Clin. Microb. 02/12/14	Japan					

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates	
		codon	nucleotide	AA	AA		Nucleotide substitution	AA	AA	AA		Phenotype: S sensitive; R resistant	Method: 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test			
AA position	AA substitution																	
138	C138R		TGT	T	Cys	C	412	C	CGT	Arg	R	3	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
138	Frameshift		TGT	del	Cys	C	412	del				1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
138	C138S		TGT	G	Cys	C	413	C	TCT	Ser	S	1	R	1	negative	1	Scorpio A. Nature 96	USA
138	C138S		TGT	G	Cys	C	413	C	TCT	Ser	S	1	R	3			Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
138	C138Y		TGT	G	Cys	C	413	A	TAT	Tyr	Y	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
138	C138Y		TGT	G	Cys	C	413	A	TAT	Tyr	Y	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
138	C138Y		TGT	G	Cys	C	413	A	TAT	Tyr	Y	1	R	3			Tracevska T. Antimicrob. Agents Chemother. 04	Latvia
138	C138Y		TGT	G	Cys	C	413	A	TAT	Tyr	Y	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
138	Frameshift		TGT	ins	Cys	C	414	G				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
138	C138C		TGT	T	Cys	C	414	C	TGC	Cys	C	2	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
138	C138W		TGT	T	Cys	C	414	G	TGG	Trp	W	1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
138	C138STOP		TGT	T	Cys	C	414	A	TGA	STOP		2	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
139	V139L		GTG	G	Val	V	415	T	TTG	Leu	L	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
139	V139L		GTG	G	Val	V	415	T	TTG	Leu	L	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
139	V139L		GTG	G	Val	V	415	C	CTG	Leu	L	2	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
139	V139L	microarray	GTG	G	Val	V	415	C	CTG	Leu	L	2	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
139	V139L		GTG	G	Val	V	415	C	CTG	Leu	L	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
139	V139L		GTG	G	Val	V	415	C	CTG	Leu	L	1	R	4			Tan Y. J. Clin. Microb. 14	China
139	V139L		GTG	G	Val	V	415	C	CTG	Leu	L	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
139	V139L		GTG	G	Val	V	415	C	CTG	Leu	L	3	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
139	V139M		GTG	G	Val	V	415	A	ATG	Met	M	3	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
139	V139M		GTG	G	Val	V	415	A	ATG	Met	M	1	R	3			Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
139	V139M		GTG	G	Val	V	415	A	ATG	Met	M	2	R	4			Lou G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
139	Frameshift		GTG	del	Val	V	416	TG				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
139	V139A		GTG	T	Val	V	416	C	GCG	Ala	A	1	R	1 ou 3			Sreevatsan S. Antimicrob. Agents Chemother. 97	USA
139	V139A		GTG	T	Val	V	416	C	GCG	Ala	A	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Malaysia
139	V139A		GTG	T	Val	V	416	C	GCG	Ala	A	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru
139	V139A		GTG	T	Val	V	416	C	GCG	Ala	A	1	R	3	negative	1	Davies A.P. J. Clin. Microbiol. 00	UK
139	V139A		GTG	T	Val	V	416	C	GCG	Ala	A	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
139	V139A		GTG	T	Val	V	416	C	GCG	Ala	A	1	R	4			Tan Y. J. Clin. Microb. 14	China
139	V139A		GTG	T	Val	V	416	C	GCG	Ala	A	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	1	R	3			Lee A. S. G. Int. J. Infect. Dis. 02	Singapore
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	2	R	3			Martin A. J. Antimicrob. Chemother. 06, 08	Eastern Europe
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	1	R	4			Perdigao J. Microb. Drug Resistance 08	Portugal
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	1	R	4			Tan Y. J. Clin. Microb. 14	China
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	1	R	4			Daum L. J Clin Microbiol 12	Texas
139	V139G		GTG	T	Val	V	416	G	GGG	Gly	G	5	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt					Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates	
		codon	nucleotide	AA	AA			Nucleotide substitution	AA	AA	AA		Phenotype: S sensitive ; R resistant	Method : 1 Proportions; 2 Rapid broths; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method : 1 Wayne 2 other test			
139	Frameshift	GTG	del	Val	V	417	G					1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
140	R140S	CGC	C	Arg	R	418	A	AGC	Ser	S		21	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	Canada	
140	Frameshift	CGC	del	Arg	R	446	del 8 bp												
140	R140G	CGC	C	Arg	R	418	G	GGC	Gly	G		1	R	3			Lily Therese K. 12	India	
140	R140S	microarray	CGC	C	Arg	R	418	A	AGC	Ser	S	14	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA	
140	Frameshift	microarray	CGC	del	Arg	R	446	del 8 bp					R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA	
140	Frameshift	CGC	del	Arg	R	419	del 68pb					1	R	3	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France	
140	R140P	CGC	G	Arg	R	419	C	CCC	Pro	P		1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
140	Frameshift	CGC	ins	Arg	R	420	G					2	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA	
140	Frameshift	CGC	ins	Arg	R	420	G	CGGC				1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan	
141	Q141STOP	CAG	C	Gln	Q	421	T	TAG	STOP	Z		1	R	3			Somoskovi A. J. Clin. Microb. 07	USA	
141	Q141STOP	CAG	C	Gln	Q	421	T	TAG	STOP	Z		1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal	
141	Q141STOP	CAG	C	Gln	Q	421	T	TAG	STOP	Z		1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea	
141	Q141STOP	CAG	C	Gln	Q	421	T	TAG	STOP	Z		1	R	1	negative	2	Park S.K. BMC Infect. Dis. 01	Korea	
	Q141STOP	CAG	C	Gln	Q	421	T	TAG	STOP	Z		1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
141	Frameshift	CAG	del	Gln	Q	421	C	AG				1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil	
141	Q141P	CAG	A	Gln	Q	422	C	CCG	Pro	P		1	R	1	negative	1	Scorpio A. Nature 96, Antimicrob Agents Chemother 97	USA	
141	Q141P	CAG	A	Gln	Q	422	C	CCG	Pro	P		2	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea	
141	Q141P	CAG	A	Gln	Q	422	C	CCG	Pro	P		1	R	3	negative	1	Martila H.J. Antimicrob. Agents Chemother. 99	North Russia	
141	Q141P	CAG	A	Gln	Q	422	C	CCG	Pro	P		1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA	
141	Q141P	microarray	CAG	A	Gln	Q	422	C	CCG	Pro	P	2	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA	
141	Q141P	microarray	CAG	A	Gln	Q	422	C	CCG	Pro	P	1	R	4			Tan Y. J. Clin. Microb. 14	China	
	Q141P	CAG	A	Gln	Q	422	C	CCG	Pro	P		11	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
141	Frameshift	CAG	ins	Gln	Q		10bp					1	R	3			Feuerrigel S. BMC Microbiology 2012	Germany	
141	Frameshift	CAG	ins	Gln	Q	423	CAG ACG GCG CCA G						1	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
142	T142P	ACG	A	Thr	T	424	G	CCG	Pro	A		1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru	
65	S65S, T142P	TCC	C	Ser	S	195	T	TCT	Ser	S		2	R	3			Somoskovi A. J. Clin. Microb. 07	USA	
142		ACG	A	Thr	T	424	C	CCG	Pro	P									
142	T142A	ACG	A	Thr	T	424	G	GCG	Ala	A		1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Myanmar	
142	T142A	ACG	A	Thr	T	424	G	GCG	Ala	A		2	R	3			Martin A. J. Antimicrob. Chemother. 06, 08	Eastern Europe	
142	T142A	ACG	A	Thr	T	424	G	GCG	Ala	A		3	R	4		2	Miotto P. mbo.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
142	T142A	ACG	A	Thr	T	424	G	GCG	Ala	A		1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland	
142	T142K	ACG	C	Thr	T	425	A	AAG	Lys	K		1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden	
142	T142K	ACG	C	Thr	T	425	A	AAG	Lys	K		2	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Thailand	
142	T142K	ACG	C	Thr	T	425	A	AAG	Lys	K		1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA	

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position	Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates					
				codon	nucleotide	AA		AA	AA	Phenotype: S sensitive ; R resistant	Méthod : 1 Proportions; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960			Pyrazinamidase activity	Method : 1 Wayne 2 other test			
AA position	AA substitution																	
142	T142K		ACG	C	Thr	T			Lys	K	1	R	3			Werngren J. Antimicrob. Agents Chemother. 11	Sweden	
142	T142K		ACG	C	Thr	T	425	A	AAG	Lys	K	1	R	4	2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
142	T142M		ACG	C	Thr	T	425	T	ATG	Met	M	1	R	3		Somoskovi A. J. Clin. Microb. 07	USA	
142	T142M		ACG	C	Thr	T	425	T	ATG	Met	M	1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Bangladesh
142	T142M		ACG	C	Thr	T	425	T	ATG	Met	M	2	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
142	T142M		ACG	C	Thr	T	425	T	ATG	Met	M	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
142	T142M		ACG	C	Thr	T	425	T	ATG	Met	M	3	R	4	2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
143	A143P		GCC	G	Ala	A	427	C	CCC	Pro	P	1	R	3, 4		Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico	
143	A143G		GCC	G	Ala	C	428	G	GGC	Gly	G	1	R	4		Piersimoni C J Clin Microb 13	Italy	
143	A143G		GCC	G	Ala	C	428	G	GGC	Gly	G	1	R	4	2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
143	Frameshift		GCC	ins	Ala	A	428	GG				1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	South Korea
144	Frameshift		GAG	del	Glu	E	430					2	R	3		Napiorkowska A The Int J Tub Lung Dis 2014	Poland	
144	no published mutation		GAG		Glu	E												
145	D145H		GAC	G	Asp	D	433	C	CAC	His	H	1	R			Lily Therese K. 12	India	
146	A146T		GCG	G	Ala	A	436	A	ACG	Thr	T	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
146	A146T		GCG	G	Ala	A	436	A	ACG	Thr	T	1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand
146	A146T		GCG	G	Ala	A	436	A	ACG	Thr	T	1	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
146	A146T		GCG	G	Ala	A	436	A	ACG	Thr	T	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
146	A146V		GCG	C	Ala	A	437	T	GTG	Val	V	3	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Inde
146	A146V		GCG	C	Ala	A	437	T	GTG	Val	V	1	R				Yoon JH World J Microbiol Biotechnol 14	Korea
146	A146E		GCG	C	Ala	A	437	A	GAG	Glu	E	2	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
146	A146E		GCG	C	Ala	A	437	A	GAG	Glu	E	1	R	3			Feuerrigel S. BMC Microbiology 2012	Germany
147	Frameshift		GTA	ins			439	CG				3	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
148	R148S		CGC	C	Arg	R	442	A	AGC	Ser	S	1	R	3	negative	1	Brown T.J. J. Med. Microbiol. 00	Turkey/UK
148	R148S		CGC	C	Arg	R	442	A	AGC	Ser	S	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
148	Frameshift		CGC	del	Arg	R	443	G				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
148	Frameshift	microarray	CGC	del	Arg	R	444	G				1	R	3			Wade M.M. Diag. Microbiol. Infect. Dis. 04	USA
148	In Frame		CGC	ins			444	ins 12 bp				1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
149	Frameshift		AAT	del	Asn	N	446	del 8 bp				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
150	Frameshift		GGC	del			449	del G				1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
151	Frameshift		TTG	del	Leu	L	452	T				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
151	L151S		TTG	T	Leu	L	452	C	TCG	Ser	S	3	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
152	Frameshift		GCC	ins	Ala	A		T				2	R	3			Clemente W.T. Diag. Microbiol. Infect. Dis. 08	Brazil
153	T153N		ACC	C	Thr	T	458	A	AAC	Asn	N	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
154	R154G		AGG	A	Arg	R	460	G	GGG	Gly	G	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
154	R154G		AGG	A	Arg	R	460	G	GGG	Gly	G	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
154	R154G		AGG	A	Arg	R	460	G	GGG	Gly	G	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
154	R154G		AGG	A	Arg	R	460	G	GGG	Gly	G	1	R	3			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
154	R154G		AGG	A	Arg	R	460	G	GGG	Gly	G	1	R	4			Daum L. J Clin Microbiol 12	Texas
155	V155M		GTG	G	Val	V	463	A	ATG	Met	M	1	R	3			Lily Therese K. 12	India
155	V155L		GTG	G	Val	V	463	T	TTG	Leu	L	1	S	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt				Nucleotide position	Substitution				No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates	
		codon	nucleotide	AA	AA		Nucleotide substitution	AA substitution	AA	AA		Phenotype: S sensitive ; R resistant	Method : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method : 1 Wayne 2 other test			
AA position	AA substitution																	
155	V155V		GTG	T	Val	V	464	G	GCG	Val	G	1	R	1			Escalante P. Tuberc. Lung Dis. 98	Peru
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	1	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	1	R	1	negative	1	Barco P. J. Antimicrob. Chemother. 06	Brazil
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	1	R		negative	1	Lee K.W. J. Korean Med Sci 01	South Korea
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	1	R	3	negative	1	Cheng S.-J. Antimicrob. Agents Chemother. 00	South Korea
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	2	R	4			Huang T.S. Antimicrob. Agents Chemother. 03	Taiwan
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	3	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	2	R	3			Werngren J. Antimicrob. Agents Chemother. 11	Sweden
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	2	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
155	V155G		GTG	T	Val	V	464	G	GGG	Gly	G	1	R	4			Hoffner S. Int. J. Tuberc. Lung Dis. 2013	Sweden
155	Frameshift		GTG	ins	Val	V		T				2	R	4			Piersimoni C J Clin Microb 13	Italy
155	Frameshift		GTG	ins	Val	V		ins CT				1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
155	Frameshift		GTG	ins	Val	V	465	T				1	R		negative	1	Lee K.W. J. Korean Med Sci 01	South Korea
156	L156P		CTG	T	Leu	L	467	C	CCG	Pro	P	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
156	L156Q		CTG	T	Leu	L	467	A	CAG	Gln	Q	1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
157	V157G		GTG	T	Val	V	470	G	GGG	Gly	G	1	ND				Post F.A. J. Infect. Dis. 04	USA/ South Africa
157	V157A		GTG	T	Val	V	470	C	GCG	Ala	A	2	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
158	no published mutation		GAC		Asp	D												
159	Frameshift		CTG	C	Leu	L	475	C	TG			1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
159	L159V		CTG	C	Leu	L	475	G	GTG	Val	V	1	R	3			Martin A. J. Antimicrob. Chemother. 06, 08	Eastern Europe
159	L159P		CTG	T	Leu	L	476	G	CGG	Arg	R	1	R		negative	1	Lee K.W. J. Korean Med Sci 01	South Korea
159	L159P		CTG	T	Leu	L	476	C	CCG	Pro	P	5	R	4			Portugal I. Antimicrob. Agents Chemother. 04	Portugal
159	L159P		CTG	T	Leu	L	476	C	CCG	Pro	P	4	R	4			Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa
159	L159P		CTG	T	Leu	L	476	C	CCG	Pro	P	1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
159	L159P		CTG	T	Leu	L	476	G	CGG	Arg	R	1	R	4			Tan Y. J. Clin. Microb. 14	China
160	T160P		ACA	A	Thr	T	478	C	CCA	Pro	P	1	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe
160	T160P		ACA	A	Thr	T	478	C	CCA	Pro	P	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
160	T160P		ACA	A	Thr	T	478	C	CCA	Pro	P	1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
161	T160K		ACA	C	Thr	T	479	A	AAA	Lys	K	1	R	3, 4			Cuevas-Cordoba B. Infection, Genetic and Evolution 2013	Mexico
160	Frameshift		ACA	ins	Thr	T	480	ins TGA C				1	R		negative	1	Lee K.W. J. Korean Med Sci 01	South Korea
160	Frameshift		ACA	ins	Thr	T	480	ins ACCCT GA				1	R	1			McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico
161	A161P		GCG	G	Ala	A	481	C	CCG	Pro	P	1	R	3	negative	1	Marttila H.J. Antimicrob. Agents Chemother. 99	North Russia
162	G162S		GGT	G	Gly	G	484	A	AGT	Ser	S	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
162	G162R		GGT	G	Gly	G	484	C	CGT	Arg	R	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Germany
162	G162D		GGT	G	Gly	G	485	A	GAT	Asp	D	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
162	G162D		GGT	G	Gly	G	485	A	GAT	Asp	D	2	R	4			Chan R.C.Y. J Antimicrob. Chemother. 07	Hong Kong
162	G162D	microarray	GGT	G	Gly	G	485	A	GAT	Asp	D	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
162	G162D		GGT	G	Gly	G	485	A	GAT	Asp	D	1	R	3			Feuerrigel S. BMC Microbiology 2012	Germany
162	G162D		GGT	G	Gly	G	485	A	GAT	Asp	D	1	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
162	G162D		GGT	G	Gly	G	485	A	GAT	Asp	D	1	R	4			Tan Y. J. Clin. Microb. 14	China
162	Frameshift		GGT	ins	Gly	G	486	T				1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
163	Frameshift		GTG	del	Val	V		del 486-496				1	R	1	negative	1	Suzuki Y. J. Clin. Microb. 02	Japan
164	S164P		TCG	T	Ser	S	490	C	CCG	Pro	P	1	R	3			Martin A. J. Antimicrob. Chemother. 06	Eastern Europe
164	Frameshift		TCG	del	Ser	S	490	T				5	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru
164	S164P, E173E		TCG	T	Ser	S	490	C	CCG	Pro	P	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
173			GAG	G	Glu	E	519	A	GAA	Glu	E							

Mutations on *pncA* and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position	Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates					
				codon	nucleotide	AA		AA	AA	Phenotype: S sensitive; R resistant	Méthod : 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960			Pyrazinamidase activity	Méthod : 1 Wayne 2 other test			
AA position	AA substitution																	
164	S164P		TCG	T	Ser	S	490	C	CCG	Pro	P	1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
165	A165D		GCC	C	Ala	A	494	A	GAC	Asp	D	1	R	3			Lily Therese K. 12	India
166	Frameshift		GAT	ins	Asp	D	493	C				1	R	2			Sekiguchi J.I. J. Clin. Microb. 07	Japan
166	Frameshift		GAT	ins	Asp	D	495	C				1	R	1	negative	1	Barco P. J Antimicrob. Chemother. 06	Brazil
167	Frameshift		ACC	ins	Thr	T	501	CG				1	R	1,3			Hou L. Epidemiol. Infect. 00	China
168	T168P		ACC	A	Thr	T	502	C	CCC	Pro	P	1	R	4			Simons S.O. J. Clin. Microb. 11	Netherlands
168	T168P		ACC	A	Thr	T	502	C	CCC	Pro	P	1	R	4			Tan Y. J. Clin. Microb. 14	China
168	T168P		ACC	A	Thr	T	502	C	CCC	Pro	P	1	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
168	T168N		ACC	C	Thr	T	503	A	AAC	Asn	N	1	R	3	negative	1	Cheng S-J. Antimicrob. Agents Chemother. 00	USA
169	Frameshift		GTC	ins	Val	V	505	CC				1	R	4			Martin A. J. Antimicrob. Chemother. 08	Eastern Europe
170	no published mutation		GCC		Ala	A												
171	A171P		GCG	G	Ala	A	511	C	CCG	Pro	P	1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
171	A171P		GCG	G	Ala	A	511	C	CCG	Pro	P	1	R	3			Sachais B. S. Molecular Diag. 98	USA
171	A171T		GCG	G	Ala	A	511	A	ACG	Thr	T	1	R	4			Portugal I. Antimicrob Agents Chemother 04	Portugal
171	A171T		GCG	G	Ala	A	511	A	ACG	Thr	T	1	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
171	A171T		GCG	G	Ala	A	511	A	ACG	Thr	T	1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Bangladesh
171	A171E		GCG	C	Ala	A	512	A	GAG	Glu	E	3	R	1	negative	1	Sumnienski Rodrigues VdF. Antimicrob. Agents Chemother. 05	Brazil
171	A171V		GCG	C	Ala	A	512	T	GTG	Val	V	1	R	3			Somoskovi A. J. Clin. Microb. 07	USA
171	A171V		GCG	C	Ala	A	512	T	GTG	Val	V	1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Scotland
171	Frameshift		GCG	del	Ala	A	512	C				1	R	3	negative	1	Mestdagh M. Antimicrob. Agents Chemother. 99	Rwanda
171	Frameshift		GCG	del	Ala	A	513	del GC				1	R	1	negative	1	Park S.K. BMC Infect. Dis. 01	Korea
172	Frameshift		CTG	del	Leu	L	514	C				1	R	4			Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
172	L172A		CTG	CT	Leu	L	514-515	GC	GCG	Ala	A	2	R	3	negative	2	Mestdagh M. Antimicrob. Agents Chemother. 99	Belgium
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	2	R	3			Juréen P. Antimicrob. Agents Chemother. 08	Sweden
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	3	R	3			Somoskovi A. J. Clin. Microb. 07	USA
172	L172P	microarray	CTG	T	Leu	L	515	C	CCG	Pro	P	1	R	3	negative	2	Denkin S. J Med. Microbiol. 05	USA
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	2	R	1	negative	1	Morlock G.P. Antimicrob. Agents Chemother. 00	CDC
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	1	R	1	negative	1	Hirano K. Tubercule Lung Dis 98	Canada
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	1	R	3			Werngren J. Antimicro. Agents Chemother. 11	Sweden
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	1	R	3			Feuerrigel S. BMC Microbiology 2012	Germany
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	2	R	4			Daum L. J Clin Microbiol 12	Texas
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	1	R	1	negative	1	Bhaju S. Infection, Genetics and Evolution 13	Brazil
172	L172P		CTG	T	Leu	L	515	C	CCG	Pro	P	9	R	4			Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
172	L172R		CTG	T	Leu	L	515	G	CGG	Arg	R	3	R	4			Stoffels K. Antimicrob. Agents Chemother. 12	Belgium
172	L172R		CTG	T	Leu	L	515	G	CGG	Arg	R	1	R	3			Napiorkowska A The Int J Tub Lung Dis 2014	Poland
172	Frameshift		CTG	del	Leu	L	515	T				1	R	3	negative	1	Mphahlele M. J Clin Microbiol 08	Norway/South Africa
172	Frameshift		CTG	ins	Leu	L	516	CG				1	R	4			Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
173	Frameshift		GAG	ins	Glu	E	518	ins 5 bp				1	R	3	negative	1	Scorpio A. Antimicrob. Agents Chemother. 97	USA
174	no published mutation		GAG		Glu	E												
174	E174STOP		GAG	G	Met	M	520	T	TAG			2	R	1			Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea
174	Frameshift			ins			520/521	GG				1	R	1	negative	1	Jonmalung J. BMC Microbiology 10	Thailand

Mutations on pncA and PZA resistance of *M. tuberculosis* complex

High frequency zone	Sensitive strain	wt	Nucleotide position	Substitution			No. of isolates	Phenotype		Pyrazinamidase		Publication	Origin of isolates					
				codon	nucl. AA	AA		Phenotype: S sensitive; R resistant	Method: 1 Proportion s; 2 Rapid broth; 3 BACTEC 460; 4 MGIT 960	Pyrazinamidase activity	Method: 1 Wayne 2 other test							
AA position	AA substitution																	
174	Frameshift		GAG	ins	Met	M	521	T			1	R	3	negative	1	Sheen P. J. Clin. Microbiol.09	Peru	
174	E174G,		GAG	A	Glu	E	521	G	GGG		G	R	4			Tan Y. J. Clin. Microb. 14	China	
175	M175R		ATG	TG	Met	M		GA	AGA	Arg	R							
175	M175V		ATG	A	Met	M	523	G	GTG	Val	V	1	R	2	negative	1	Sekiguchi J.I. J. Clin. Microb. 07	Japan
175	M175V		ATG	A	Met	M	523	G	GTG	Val	V	1	R	1		McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico	
175	M175V		ATG	A	Met	M	523	G	GTG	Val	V	1	R	4		Stoffels K. Antimicrob. Agents Chemother. 12	Belgium	
175	M175V		ATG	A	Met	M	523	G	GTG	Val	V	6	R	4		Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden	
175	M175V		ATG	A	Met	M	523	G	GTG	Val	V	4	R	3		Napiorkowska A The Int J Tub Lung Dis 2014	Poland	
175	M175T		ATG	T	Met	M	524	C	ACG	Thr	T	1	R	4		Chan R.C.Y. J Antimicrob. Chemother. 07	Hong Kong	
175	M175T		ATG	T	Met	M	524	C	ACG	Thr	T	1	R	3		Juréen P. Antimicrob. Agents Chemother. 08	Sweden	
175	M175T		ATG	T	Met	M	524	C	ACG	Thr	T	1	R	3		Wengren J. Antimicro. Agents Chemother. 11	Sweden	
175	M175T		ATG	T	Met	M	524	C	ACG	Thr	T	1	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
175	M175R		ATG	T	Met	M	524	A	AGG	Arg	R	1	R	1		Jnawali H.N. Diag. Microb. And Infect. Dis.13	Korea	
175	M175I		ATG	G	Met	M	525	A	ATA	Ile	I	1	R	3		Clemente W.T. Diag. Microbiol. Infect. Dis. 08	Brazil	
175	M175I		ATG	G	Met	M	525	A	ATA	Ile	I	2	R	4		Stoffels K. Antimicrob. Agents Chemother. 12	Belgium	
175	M175I		ATG	G	Met	M	525	A	ATA	Ile	I	10	R	4		2	Miotto P. mbio.asm.org 14	Italy, Germany, UK, Lithuania, Poland, Sweden
65	S65S,		TCC	C	Ser	S	195	T	TCT	Ser	S	1	R	3		Juréen P. Antimicrob. Agents Chemother. 08	Sweden	
176	Frameshift		CGC	ins			528	GC									Sweden	
177	Frameshift		ACC	ins				CG				1	R	3		Somoskovi A. J. Clin. Microb. 07	USA	
178	Frameshift		ACC	del			531	6 bp				3	R	3		Napiorkowska A The Int J Tub Lung Dis 2014	Poland	
178	Frameshift		GCC	ins	Ala	A	532	C				1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
178	A178D		GCC	C	Ala	A	533	A	GAC	Asp	D	1	R	3		Lily Therese K. 12	India	
179	S179R		AGC	A	Ser	S	535	C	CGC	Arg	R	2	R	4		Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa	
179	S179C		AGC	A	Ser	S	535	T	TGC	Cys	C	1	R	3		Lily Therese K. 12	India	
180	V180F		GTC	G	Val	V	538	T	TTC	Phe	F	1	R		negative	1	Lee K.W. J Korean Med Sci 01	South Korea
180	V180F		GTC	G	Val	V	538	T	TTC	Phe	F	1	R	3		Tracevska T. Antimicrob. Agents Chemother. 04	Latvia	
180	V180F		GTC	G	Val	V	538	T	TTC	Phe	F	1	R	3		McCammon M.T. Antimicrob. Agents Chemother. 05	USATexas/Mexico	
180	V180F		GTC	G	Val	V	538	T	TTC	Phe	F	1	R	3		Somoskovi A. J. Clin. Microb. 07	USA	
180	V180A		GTC	G	Val	V	539	T	GTC	Ala	A	1	R	3		Lee A. S. G. Int. J. Infect. Dis. 02	Singapore	
181	E181D		GAG	G	Glu	E	543	T	GAT	Asp	D	1	R	4		Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa	
181	Frameshift		GAG	del				del AGT				1	R	3		Somoskovi A. J. Clin. Microb. 07	USA	
182	L182S		TTG	T	Leu	L	545	C	TCG	Ser	S	1	R	1	negative	1	Lemaitre N. Antimicrob. Agents Chemother. 99	France
183	V183F		GTT	G	Val	V	547	T	TTT	Phe	F	1	R	3		Lily Therese K. 12	India	
184	no published mutation		TGC		Cys	C												
185	S185T		AGC	G	Ser	S	554	C	ACC	Thr	T	8	R	4		Louw G.E. Int. J. Tuberc. Lung Dis. 06	South Africa	
186	no published mutation		TCC		Ser	S												
187	no published mutation		TGA		STOP	Z												