Full wwPDB X-ray Structure Validation Report (i)

Feb 21, 2024 – 03:54 AM EST

PDB ID	:	4Q9D
Title	:	X-ray structure of a putative thiamin diphosphate-dependent enzyme isolated from Mycobacterium smegmatis
Authors	:	Andrews, F.H.; Horton, J.D.; Yoon, H.J.; Malik, A.M.K.; Logsdon, M.G.; Shin, D.H.; Kneen, M.M.; Suh, S.W.; McLeish, M.J.
Deposited on	:	2014-04-30
Resolution	:	2.20 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at *validation@mail.wwpdb.org*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

The following versions of software and data (see references (i)) were used in the production of this report:

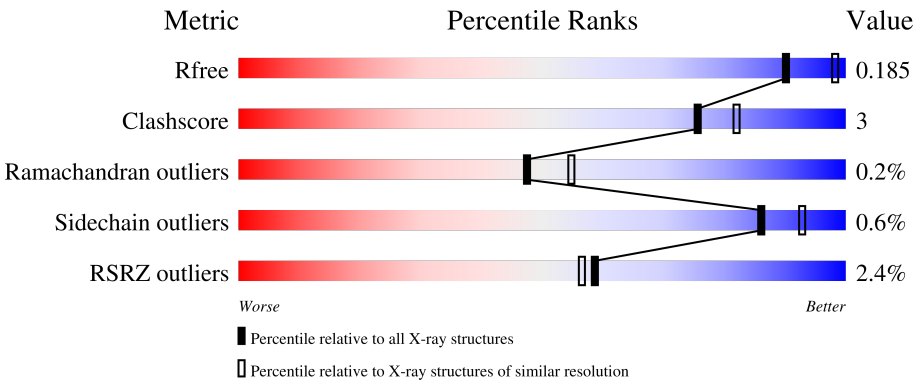
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5% The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	545	3% 88% 7% 5%
1	B	545	% 90% 5% 5%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	FMT	A	603	-	-	X	-

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 8691 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called Benzoylformate decarboxylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	517	3875	2470	648	742	15	0	0	0
1	B	519	3895	2483	650	746	16	0	1	0

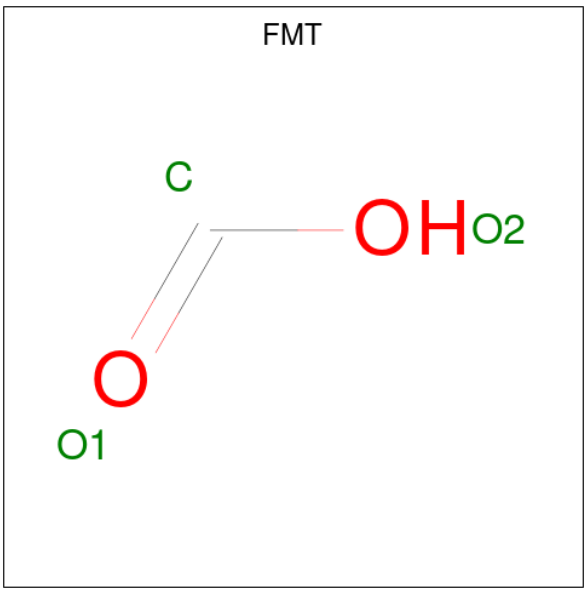
There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	538	ARG	-	expression tag	UNP A0QSU7
A	539	SER	-	expression tag	UNP A0QSU7
A	540	HIS	-	expression tag	UNP A0QSU7
A	541	HIS	-	expression tag	UNP A0QSU7
A	542	HIS	-	expression tag	UNP A0QSU7
A	543	HIS	-	expression tag	UNP A0QSU7
A	544	HIS	-	expression tag	UNP A0QSU7
A	545	HIS	-	expression tag	UNP A0QSU7
B	538	ARG	-	expression tag	UNP A0QSU7
B	539	SER	-	expression tag	UNP A0QSU7
B	540	HIS	-	expression tag	UNP A0QSU7
B	541	HIS	-	expression tag	UNP A0QSU7
B	542	HIS	-	expression tag	UNP A0QSU7
B	543	HIS	-	expression tag	UNP A0QSU7
B	544	HIS	-	expression tag	UNP A0QSU7
B	545	HIS	-	expression tag	UNP A0QSU7

- Molecule 2 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mg		
2	A	1	1	1	0	0
2	B	1	1	1	0	0

- Molecule 3 is FORMIC ACID (three-letter code: FMT) (formula: CH_2O_2).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	A	1	3	1	2	0	0
			Total	C	O		
3	A	1	3	1	2	0	0
			Total	C	O		
3	B	1	3	1	2	0	0
			Total	C	O		
3	B	1	3	1	2	0	0

- Molecule 4 is water.

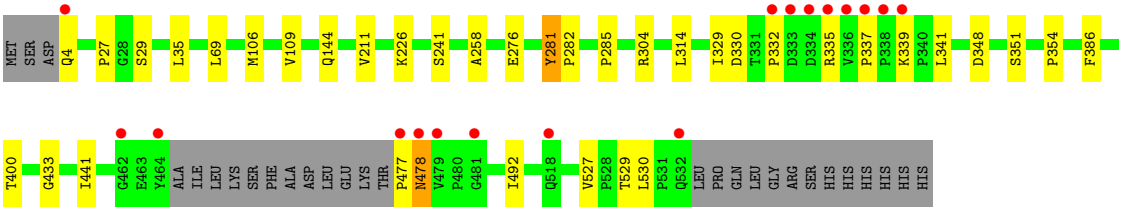
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	388	388	388	0	0
			Total	O		
4	B	519	519	519	0	0

3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density (RSRZ > 2). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

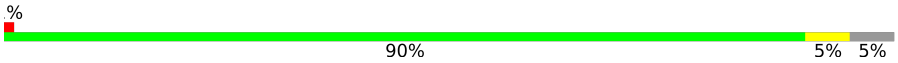
• Molecule 1: Benzoylformate decarboxylase

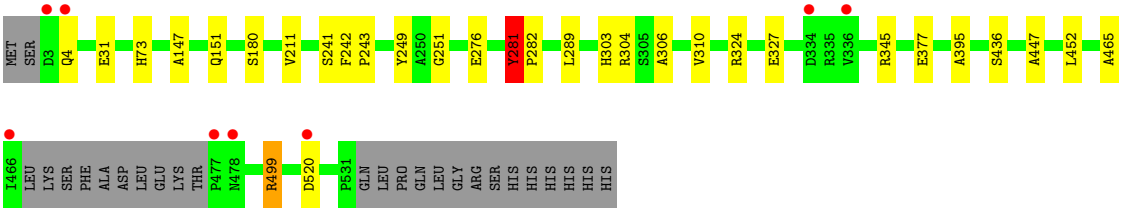
Chain A:



• Molecule 1: Benzoylformate decarboxylase

Chain B:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α, β, γ	137.16Å 137.16Å 337.06Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	35.90 – 2.20 48.55 – 2.20	Depositor EDS
% Data completeness (in resolution range)	100.0 (35.90-2.20) 96.1 (48.55-2.20)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	0.09	Depositor
$< I/\sigma(I) >$ [1]	5.17 (at 2.20Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.2_1309)	Depositor
R, R_{free}	0.150 , 0.185 0.153 , 0.185	Depositor DCC
R_{free} test set	4788 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å^2)	32.5	Xtriage
Anisotropy	0.163	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 46.2	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	8691	wwPDB-VP
Average B, all atoms (Å^2)	32.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.40% of the height of the origin peak. No significant pseudotranslation is detected.*

[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: FMT, MG

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\#\|Z\|>5$	RMSZ	$\#\|Z\|>5$
1	A	0.57	0/3975	0.64	1/5451 (0.0%)
1	B	0.60	0/3995	0.66	2/5478 (0.0%)
All	All	0.58	0/7970	0.65	3/10929 (0.0%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	499	ARG	NE-CZ-NH1	5.92	123.26	120.30
1	B	499	ARG	NE-CZ-NH2	-5.48	117.56	120.30
1	A	69	LEU	CA-CB-CG	5.10	127.03	115.30

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts (i)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3875	0	3825	25	1
1	B	3895	0	3845	25	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	6	0	2	2	0
3	B	6	0	2	0	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	A	388	0	0	1	0
4	B	519	0	0	5	0
All	All	8691	0	7674	48	1

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 3.

All (48) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:281:TYR:HB3	1:B:282:PRO:CD	1.72	1.19
1:B:281:TYR:HB3	1:B:282:PRO:HD3	1.33	1.06
1:A:339:LYS:HA	1:A:339:LYS:HE2	1.54	0.88
1:B:281:TYR:CB	1:B:282:PRO:CD	2.55	0.85
1:B:276:GLU:HG2	1:B:304:ARG:HD2	1.64	0.78
1:B:281:TYR:HB3	1:B:282:PRO:HD2	1.65	0.74
1:B:281:TYR:CB	1:B:282:PRO:HD3	2.15	0.74
1:B:324:ARG:NH1	1:B:327:GLU:OE1	2.32	0.62
1:A:281:TYR:HB3	1:A:282:PRO:CD	2.30	0.61
1:B:499:ARG:HD2	4:B:1208:HOH:O	2.01	0.61
1:B:345:ARG:HD2	4:B:1154:HOH:O	2.01	0.60
1:A:144:GLN:HG3	1:B:306:ALA:O	2.02	0.59
1:B:465:ALA:HB2	4:B:1179:HOH:O	2.02	0.58
1:A:433:GLY:HA3	3:A:603:FMT:H	1.87	0.55
1:A:27:PRO:HB3	1:A:35:LEU:CD1	2.36	0.55
1:B:249:TYR:CZ	1:B:251:GLY:HA2	2.44	0.52
1:A:335:ARG:O	1:A:337:PRO:HD3	2.11	0.51
1:B:211:VAL:HB	1:B:241:SER:HB3	1.93	0.51
1:A:527:VAL:O	1:A:529:THR:HG23	2.13	0.49
1:A:354:PRO:HG2	1:A:530:LEU:HD21	1.95	0.48
4:A:1080:HOH:O	1:B:303:HIS:HD2	1.96	0.48
1:B:276:GLU:HG2	1:B:304:ARG:CD	2.39	0.48
1:B:304:ARG:HD3	1:B:304:ARG:HA	1.50	0.46
1:A:330:ASP:O	1:A:332:PRO:HD3	2.16	0.45
1:B:147:ALA:O	1:B:151:GLN:HG3	2.16	0.45
1:A:211:VAL:HB	1:A:241:SER:HB3	1.99	0.45
1:A:477:PRO:HA	1:A:478:ASN:HA	1.77	0.45
1:A:478:ASN:OD1	1:A:478:ASN:N	2.50	0.44
1:A:433:GLY:HA3	3:A:603:FMT:C	2.48	0.44
1:B:289:LEU:HG	1:B:310:VAL:HG21	2.00	0.43
1:A:341:LEU:HD21	1:A:386:PHE:HZ	1.84	0.43

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:447:ALA:HA	1:B:452:LEU:HD12	2.00	0.43
1:A:281:TYR:HB3	1:A:282:PRO:HD2	2.01	0.43
1:A:281:TYR:CB	1:A:282:PRO:CD	2.95	0.43
1:A:348:ASP:O	1:A:351:SER:HB2	2.19	0.43
1:A:441:ILE:HD13	1:A:492:ILE:HG21	2.00	0.42
1:B:395:ALA:HB1	4:B:1214:HOH:O	2.19	0.42
1:B:4:GLN:HB3	4:B:1170:HOH:O	2.20	0.42
1:B:31:GLU:CD	1:B:73:HIS:HA	2.40	0.42
1:A:339:LYS:HA	1:A:339:LYS:CE	2.32	0.42
1:B:242:PHE:CD1	1:B:243:PRO:HD2	2.54	0.41
1:A:314:LEU:HA	1:B:180:SER:OG	2.20	0.41
1:A:106:MET:O	1:A:109:VAL:HG22	2.21	0.41
1:A:226:LYS:HE2	1:A:329:ILE:HG13	2.03	0.41
1:A:281:TYR:HB3	1:A:282:PRO:HD3	2.02	0.41
1:A:258:ALA:HB2	1:A:285:PRO:O	2.21	0.41
1:B:377:GLU:HG2	1:B:436:SER:HB3	2.03	0.40
1:A:276:GLU:HG2	1:A:304:ARG:NE	2.36	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:29:SER:OG	1:A:281:TYR:OH[10_664]	2.09	0.11

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	513/545 (94%)	505 (98%)	7 (1%)	1 (0%)	47	55
1	B	516/545 (95%)	505 (98%)	10 (2%)	1 (0%)	47	55
All	All	1029/1090 (94%)	1010 (98%)	17 (2%)	2 (0%)	47	55

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	281	TYR
1	B	281	TYR

5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	411/436 (94%)	408 (99%)	3 (1%)	84	91
1	B	413/436 (95%)	411 (100%)	2 (0%)	88	94
All	All	824/872 (94%)	819 (99%)	5 (1%)	86	93

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	4	GLN
1	A	400	THR
1	A	478	ASN
1	B	281	TYR
1	B	520	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA (i)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 6 ligands modelled in this entry, 2 are monoatomic - leaving 4 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
3	FMT	A	603	-	2,2,2	0.62	0	1,1,1	0.37	0
3	FMT	B	603	2	2,2,2	0.79	0	1,1,1	0.37	0
3	FMT	B	602	-	2,2,2	0.65	0	1,1,1	0.48	0
3	FMT	A	602	-	2,2,2	0.63	0	1,1,1	0.45	0

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	603	FMT	2	0

5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data (i)

6.1 Protein, DNA and RNA chains (i)

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2			OWAB(Å^2)	Q<0.9
1	A	517/545 (94%)	-0.41	17 (3%)	46	44	18, 30, 64, 113	0
1	B	519/545 (95%)	-0.67	8 (1%)	73	72	17, 26, 48, 97	0
All	All	1036/1090 (95%)	-0.54	25 (2%)	59	56	17, 27, 53, 113	0

All (25) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	336	VAL	10.3
1	A	478	ASN	8.7
1	B	477	PRO	7.5
1	A	335	ARG	6.6
1	A	337	PRO	4.5
1	A	477	PRO	4.3
1	A	334	ASP	4.3
1	A	479	VAL	4.0
1	B	3	ASP	4.0
1	A	332	PRO	3.9
1	A	464	TYR	3.9
1	A	532	GLN	3.7
1	A	339	LYS	3.1
1	B	334	ASP	3.0
1	A	518	GLN	3.0
1	A	338	PRO	2.9
1	B	466	ILE	2.9
1	B	478	ASN	2.9
1	B	4	GLN	2.8
1	A	333	ASP	2.6
1	A	462	GLY	2.4
1	A	481	GLY	2.4
1	B	336	VAL	2.3
1	B	520	ASP	2.3

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	4	GLN	2.0

6.2 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates (i)

There are no monosaccharides in this entry.

6.4 Ligands (i)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	MG	A	601	1/1	0.82	0.19	75,75,75,75	0
3	FMT	A	603	3/3	0.95	0.17	53,53,59,60	0
2	MG	B	601	1/1	0.97	0.04	32,32,32,32	0
3	FMT	B	603	3/3	0.98	0.09	31,31,34,36	0
3	FMT	B	602	3/3	0.99	0.07	27,27,29,30	0
3	FMT	A	602	3/3	0.99	0.07	26,26,26,29	0

6.5 Other polymers (i)

There are no such residues in this entry.