Full wwPDB X-ray Structure Validation Report ⓘ

Aug 21, 2023 – 11:03 AM EDT

PDB ID	:	2PWZ
Title	:	Crystal structure of the apo form of E.Coli malate dehydrogenase
Authors	:	Soderberg, C.A.G.; Clarke, T.A.; Richardson, D.J.; Hemmings, A.M.
Deposited on	:	2007-05-14
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 ⓘ 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 ⓘ) were used in the production of this report:

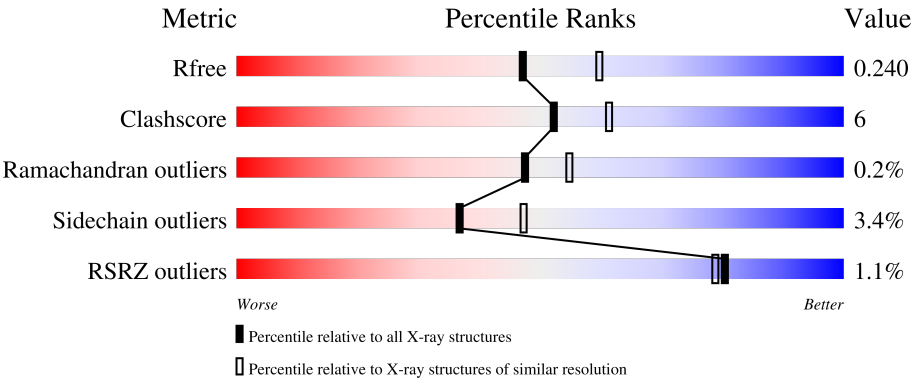
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.35
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35

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	312	86% 12% •
1	C	312	87% 11% ••
1	E	312	89% 10% •
1	G	312	86% 13% •

2 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 9470 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 Malate dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	312	Total	C	N	O	S	0	1	0
			2278	1442	387	442	7			
1	C	308	Total	C	N	O	S	0	1	0
			2250	1424	382	438	6			
1	E	312	Total	C	N	O	S	0	0	0
			2272	1438	386	441	7			
1	G	312	Total	C	N	O	S	0	0	0
			2272	1438	386	441	7			

- Molecule 2 is water.

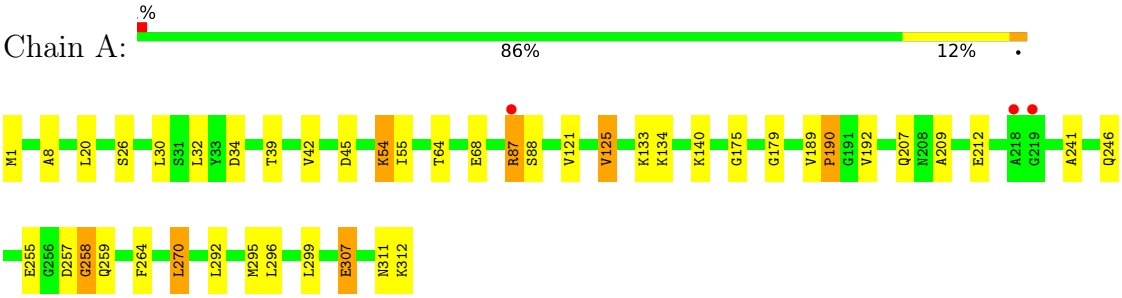
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	114	Total	O	0	0
			114	114		
2	C	104	Total	O	0	0
			104	104		
2	E	96	Total	O	0	0
			96	96		
2	G	84	Total	O	0	0
			84	84		

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.

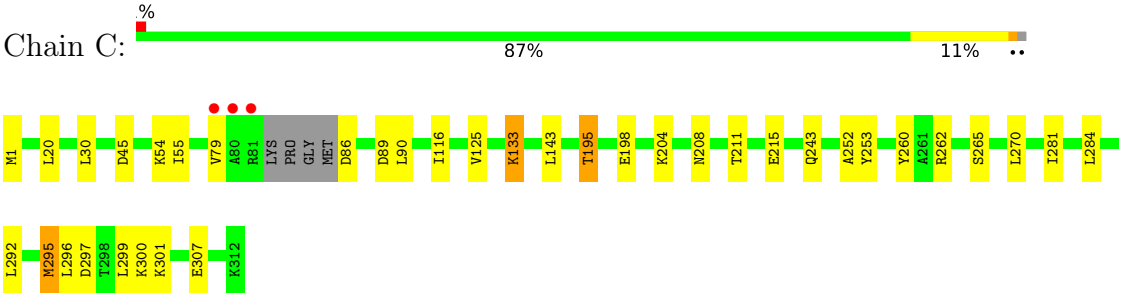
• Molecule 1: Malate dehydrogenase

Chain A:



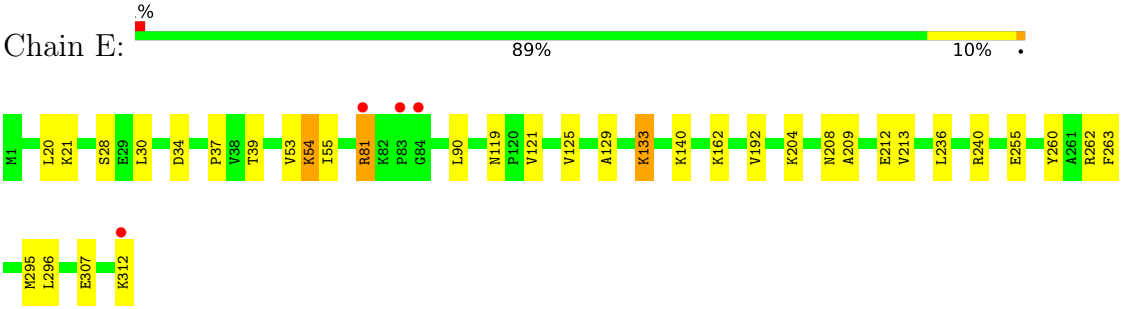
• Molecule 1: Malate dehydrogenase

Chain C:



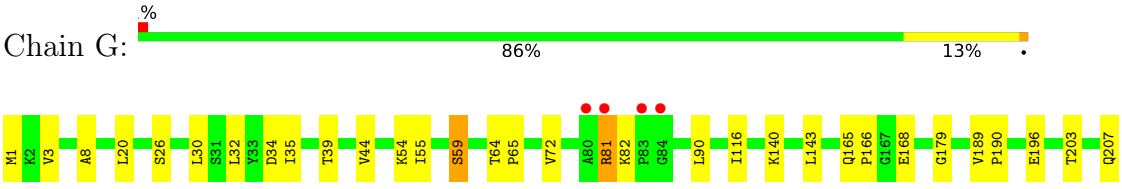
• Molecule 1: Malate dehydrogenase

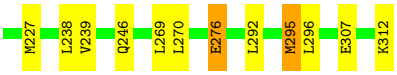
Chain E:



• Molecule 1: Malate dehydrogenase

Chain G:




M227
L238
V239
Q246
L269
L270
E276
L292
M295
L296
E307
K312

4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	146.47Å 52.48Å 170.20Å 90.00° 102.28° 90.00°	Depositor
Resolution (Å)	50.00 – 2.20 49.30 – 2.20	Depositor EDS
% Data completeness (in resolution range)	97.6 (50.00-2.20) 97.6 (49.30-2.20)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	0.12	Depositor
$< I/\sigma(I) >$ [1]	2.32 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.199 , 0.246 0.195 , 0.240	Depositor DCC
R_{free} test set	3211 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å^2)	21.6	Xtriage
Anisotropy	0.599	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 37.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	9470	wwPDB-VP
Average B, all atoms (Å^2)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.85% 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

5.1 Standard geometry

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	0.71	1/2309 (0.0%)	0.74	0/3126
1	C	0.75	1/2279 (0.0%)	0.72	1/3085 (0.0%)
1	E	0.69	1/2300 (0.0%)	0.71	0/3114
1	G	0.65	1/2300 (0.0%)	0.69	0/3114
All	All	0.70	4/9188 (0.0%)	0.72	1/12439 (0.0%)

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	307	GLU	CD-OE2	7.72	1.34	1.25
1	G	307	GLU	CD-OE2	7.53	1.33	1.25
1	E	307	GLU	CD-OE2	7.50	1.33	1.25
1	A	307	GLU	CD-OE2	7.13	1.33	1.25

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	C	45	ASP	CB-CG-OD1	5.50	123.25	118.30

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

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	2278	0	2365	34	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	C	2250	0	2332	24	0
1	E	2272	0	2357	20	0
1	G	2272	0	2357	27	0
2	A	114	0	0	3	0
2	C	104	0	0	2	0
2	E	96	0	0	2	0
2	G	84	0	0	5	0
All	All	9470	0	9411	102	0

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 6.

All (102) 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:A:258:GLY:N	2:A:357:HOH:O	1.93	0.98
1:A:257:ASP:OD1	1:A:257:ASP:O	1.87	0.93
1:A:257:ASP:C	2:A:357:HOH:O	2.06	0.93
1:A:87:ARG:H	1:A:87:ARG:HD3	1.35	0.91
1:G:196:GLU:HB2	2:G:322:HOH:O	1.69	0.91
1:G:140:LYS:HD3	2:G:389:HOH:O	1.72	0.87
1:A:312:LYS:HA	1:A:312:LYS:HE3	1.62	0.81
1:C:195:THR:HG22	1:C:198:GLU:H	1.48	0.77
1:E:119:ASN:HD22	1:E:121:VAL:H	1.39	0.69
1:A:257:ASP:CA	2:A:357:HOH:O	2.41	0.65
1:C:204:LYS:HD2	1:C:208:ASN:HD21	1.62	0.63
1:G:292:LEU:HD12	1:G:295:MET:CE	2.28	0.62
1:C:116:ILE:CD1	1:C:143:LEU:HD11	2.29	0.62
1:G:292:LEU:HD12	1:G:295:MET:HE1	1.81	0.62
1:A:257:ASP:O	1:A:259:GLN:N	2.29	0.60
1:C:116:ILE:HD12	1:C:143:LEU:HD11	1.86	0.58
1:A:140:LYS:HG3	1:A:255:GLU:HB3	1.86	0.58
1:G:30:LEU:O	1:G:55:ILE:HA	2.04	0.57
1:E:30:LEU:HD23	1:E:55:ILE:HD12	1.86	0.57
1:A:87:ARG:HD3	1:A:87:ARG:N	2.15	0.57
1:A:179:GLY:O	1:A:207:GLN:HG2	2.05	0.56
1:E:54:LYS:H	1:E:54:LYS:CD	2.20	0.55
1:E:236:LEU:O	1:E:240:ARG:HG3	2.07	0.54
1:A:121:VAL:O	1:A:125:VAL:HG13	2.06	0.54
1:C:1:MET:CE	1:C:243:GLN:HG3	2.38	0.54
1:A:134:LYS:HE2	1:A:311:ASN:ND2	2.23	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:86:ASP:HB3	1:C:89:ASP:OD2	2.07	0.54
1:G:269:LEU:HD23	1:G:276:GLU:HG2	1.89	0.54
1:E:312:LYS:HG3	2:E:380:HOH:O	2.08	0.53
1:A:34:ASP:HB3	1:A:39:THR:OG1	2.09	0.53
1:A:87:ARG:HH11	1:A:87:ARG:HG2	1.74	0.52
1:C:125:VAL:HG22	1:C:253:TYR:HE2	1.73	0.52
1:C:295:MET:HE3	1:C:299:LEU:HB2	1.90	0.51
1:A:54:LYS:CD	1:A:54:LYS:H	2.24	0.50
1:A:209:ALA:O	1:A:212:GLU:HB3	2.11	0.50
1:A:54:LYS:H	1:A:54:LYS:HD2	1.77	0.50
1:A:312:LYS:HA	1:A:312:LYS:CE	2.33	0.50
1:A:30:LEU:O	1:A:55:ILE:HA	2.12	0.50
1:A:292:LEU:O	1:A:296:LEU:HD13	2.12	0.49
1:G:203:THR:O	1:G:207:GLN:HG3	2.13	0.49
1:G:34:ASP:HB3	1:G:39:THR:OG1	2.13	0.48
1:C:125:VAL:HG22	1:C:253:TYR:CE2	2.49	0.48
1:E:28:SER:O	1:E:54:LYS:HD3	2.12	0.48
1:G:179:GLY:HA3	2:G:393:HOH:O	2.14	0.48
1:G:1:MET:HG2	1:G:239:VAL:HG13	1.96	0.47
1:E:129:ALA:O	1:E:133:LYS:HG2	2.14	0.47
1:E:209:ALA:O	1:E:212:GLU:HB3	2.14	0.47
1:C:30:LEU:O	1:C:55:ILE:HA	2.14	0.47
1:E:21:LYS:NZ	1:E:53:VAL:O	2.40	0.47
1:G:295:MET:CE	1:G:296:LEU:HD12	2.45	0.47
1:A:87:ARG:HG2	1:A:87:ARG:NH1	2.30	0.47
1:G:140:LYS:HB3	2:G:389:HOH:O	2.15	0.47
1:A:64:THR:O	1:A:68:GLU:HG3	2.16	0.46
1:C:125:VAL:HG21	1:C:253:TYR:CD2	2.51	0.46
1:A:87:ARG:HH11	1:A:88:SER:H	1.64	0.46
1:C:133:LYS:HZ1	1:C:262:ARG:HH12	1.64	0.46
1:E:262:ARG:HG2	1:E:263:PHE:CE1	2.51	0.46
1:E:81:ARG:O	1:E:81:ARG:HG3	2.15	0.46
1:C:252:ALA:O	1:C:265:SER:HA	2.17	0.45
1:C:297:ASP:O	1:C:301:LYS:HG3	2.15	0.45
1:A:246:GLN:HG3	1:G:26:SER:OG	2.16	0.45
1:C:260:TYR:CE1	1:C:292:LEU:HD21	2.52	0.45
1:C:211:THR:O	1:C:215:GLU:HG3	2.17	0.45
1:G:292:LEU:HD12	1:G:295:MET:HE2	1.98	0.45
1:E:54:LYS:H	1:E:54:LYS:HD3	1.82	0.45
1:A:87:ARG:H	1:A:87:ARG:CD	2.19	0.44
1:G:8:ALA:CB	1:G:32:LEU:HB3	2.47	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:1:MET:HE3	1:C:243:GLN:HG3	1.98	0.44
1:E:140:LYS:HE3	1:E:255:GLU:O	2.18	0.44
1:G:196:GLU:CB	2:G:322:HOH:O	2.46	0.44
1:G:116:ILE:CD1	1:G:143:LEU:HD11	2.47	0.44
1:C:281:ILE:HD12	1:C:284:LEU:HD21	2.00	0.44
1:A:26:SER:OG	1:G:246:GLN:HG2	2.17	0.44
1:A:189:VAL:HA	1:A:190:PRO:HD2	1.82	0.43
1:E:260:TYR:HB3	1:E:296:LEU:HD21	2.00	0.43
1:G:34:ASP:O	1:G:59:SER:HA	2.18	0.43
1:C:125:VAL:CG2	1:C:253:TYR:CE2	3.02	0.43
1:C:54:LYS:HE2	2:C:409:HOH:O	2.18	0.43
1:C:54:LYS:HE3	1:C:54:LYS:HB2	1.81	0.43
1:A:175:GLY:HA2	1:A:264:PHE:CE1	2.54	0.42
1:E:34:ASP:HB3	1:E:39:THR:OG1	2.18	0.42
1:C:195:THR:HG23	2:C:368:HOH:O	2.19	0.42
1:G:295:MET:HE3	1:G:296:LEU:HD12	2.01	0.42
1:G:64:THR:HB	1:G:65:PRO:HD3	2.02	0.42
1:G:165:GLN:O	1:G:168:GLU:HB2	2.19	0.42
1:E:213:VAL:HG22	1:G:44:VAL:HG12	2.02	0.42
1:G:165:GLN:HA	1:G:166:PRO:HD3	1.86	0.42
1:G:3:VAL:HG22	1:G:72:VAL:HB	2.02	0.41
1:A:8:ALA:CB	1:A:32:LEU:HB3	2.51	0.41
1:A:241:ALA:CB	1:A:270:LEU:HB3	2.50	0.41
1:C:296:LEU:O	1:C:300:LYS:HG3	2.20	0.41
1:E:204:LYS:HE3	1:E:208:ASN:HD21	1.85	0.41
1:E:262:ARG:HG2	1:E:263:PHE:CD1	2.55	0.41
1:E:37:PRO:HD2	2:E:320:HOH:O	2.20	0.41
1:G:227:MET:HE2	1:G:227:MET:O	2.21	0.41
1:A:42:VAL:O	1:A:45:ASP:HB3	2.20	0.41
1:G:189:VAL:HA	1:G:190:PRO:HD3	1.96	0.41
1:A:190:PRO:O	1:A:192:VAL:N	2.47	0.41
1:C:116:ILE:HD11	1:C:143:LEU:HD11	2.02	0.41
1:E:162:LYS:HD3	1:E:192:VAL:HG23	2.01	0.41
1:A:307:GLU:H	1:A:307:GLU:HG3	1.66	0.40
1:A:295:MET:SD	1:A:299:LEU:HD22	2.62	0.40

There are no symmetry-related clashes.

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	311/312 (100%)	303 (97%)	6 (2%)	2 (1%)	25	26
1	C	305/312 (98%)	300 (98%)	5 (2%)	0	100	100
1	E	310/312 (99%)	304 (98%)	6 (2%)	0	100	100
1	G	310/312 (99%)	301 (97%)	8 (3%)	1 (0%)	41	46
All	All	1236/1248 (99%)	1208 (98%)	25 (2%)	3 (0%)	47	55

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	G	81	ARG
1	A	258	GLY
1	A	190	PRO

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	242/241 (100%)	235 (97%)	7 (3%)	42	54
1	C	239/241 (99%)	232 (97%)	7 (3%)	42	54
1	E	241/241 (100%)	234 (97%)	7 (3%)	42	54
1	G	241/241 (100%)	229 (95%)	12 (5%)	24	30
All	All	963/964 (100%)	930 (97%)	33 (3%)	37	47

All (33) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	MET
1	A	20	LEU
1	A	54	LYS
1	A	87	ARG
1	A	125	VAL
1	A	133	LYS
1	A	270	LEU
1	C	20	LEU
1	C	79	VAL
1	C	90	LEU
1	C	133	LYS
1	C	195	THR
1	C	270	LEU
1	C	295	MET
1	E	20	LEU
1	E	54	LYS
1	E	81	ARG
1	E	90	LEU
1	E	125	VAL
1	E	133	LYS
1	E	295	MET
1	G	20	LEU
1	G	35	ILE
1	G	54	LYS
1	G	59	SER
1	G	81	ARG
1	G	82	LYS
1	G	90	LEU
1	G	238	LEU
1	G	270	LEU
1	G	276	GLU
1	G	295	MET
1	G	312	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (9) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	100	ASN
1	A	311	ASN
1	C	208	ASN
1	C	311	ASN
1	E	100	ASN
1	E	119	ASN

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Mol	Chain	Res	Type
1	E	311	ASN
1	G	100	ASN
1	G	103	GLN

5.3.3 RNA

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains

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

5.5 Carbohydrates

There are no monosaccharides in this entry.

5.6 Ligand geometry

There are no ligands in this entry.

5.7 Other polymers

There are no such residues in this entry.

5.8 Polymer linkage issues

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

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, 95^{th} 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	312/312 (100%)	-0.32	3 (0%)	82	81	8, 16, 31, 47	0
1	C	308/312 (98%)	-0.33	3 (0%)	82	81	6, 16, 31, 62	0
1	E	312/312 (100%)	-0.28	4 (1%)	77	75	9, 19, 35, 62	0
1	G	312/312 (100%)	-0.24	4 (1%)	77	75	10, 21, 39, 62	0
All	All	1244/1248 (99%)	-0.29	14 (1%)	80	79	6, 18, 36, 62	0

All (14) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	80	ALA	7.4
1	E	83	PRO	5.7
1	E	84	GLY	3.7
1	G	83	PRO	3.4
1	E	81	ARG	3.0
1	A	87	ARG	2.9
1	G	81	ARG	2.6
1	G	84	GLY	2.4
1	A	218	ALA	2.4
1	C	81	ARG	2.4
1	E	312	LYS	2.3
1	C	79	VAL	2.2
1	A	219	GLY	2.2
1	G	80	ALA	2.1

6.2 Non-standard residues in protein, DNA, RNA chains

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)

There are no ligands in this entry.

6.5 Other polymers (i)

There are no such residues in this entry.