



Full wwPDB X-ray Structure Validation Report ⓘ

Sep 3, 2017 – 09:38 PM EDT

PDB ID : 5UNI
Title : Critical role of water molecules for proton translocation of the membrane-bound transhydrogenase
Authors : Padayatti, P.S.; Leung, J.H.
Deposited on : unknown
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

<http://wwpdb.org/validation/2016/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467
Mogul : 1.7.2 (RC1), CSD as538be (2017)
Xtriage (Phenix) : 1.9-1692
EDS : rb-20029824
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)
Refmac : 5.8.0135
CCP4 : 6.5.0
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : rb-20029824

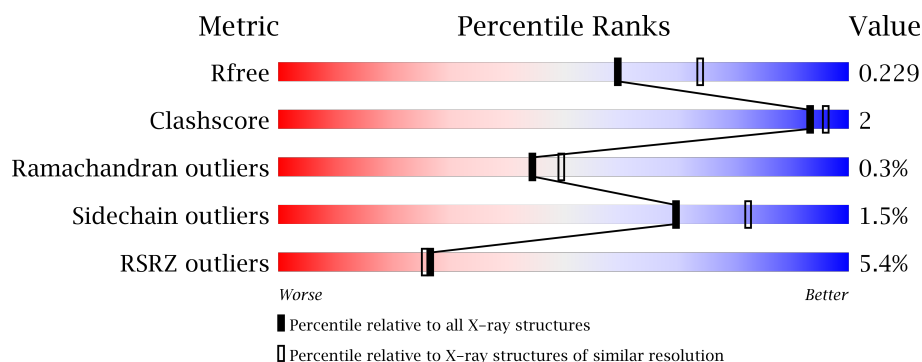
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION


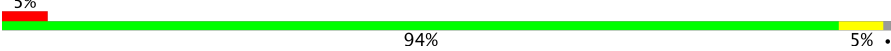
The reported resolution of this entry is 2.20 Å.

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}	100719	4002 (2.20-2.20)
Clashscore	112137	4730 (2.20-2.20)
Ramachandran outliers	110173	4656 (2.20-2.20)
Sidechain outliers	110143	4657 (2.20-2.20)
RSRZ outliers	101464	4033 (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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. 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 $\leq 5\%$. 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	94	
2	B	264	

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	1PE	A	101	-	-	-	X
4	PEG	A	103	-	-	-	X
4	PEG	A	104	-	-	-	X
4	PEG	B	308	-	-	-	X
4	PEG	B	309	-	-	-	X
5	OLC	B	301	-	-	-	X
5	OLC	B	302	-	-	-	X
6	BEN	B	311	-	-	-	X
6	BEN	B	312	-	-	-	X

2 Entry composition

There are 7 unique types of molecules in this entry. The entry contains 2829 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 NAD(P) transhydrogenase subunit alpha 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	94	Total	C	N	O	S	0	0	0
			710	473	114	117	6			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	16	CYS	ALA	conflict	UNP Q72GR9

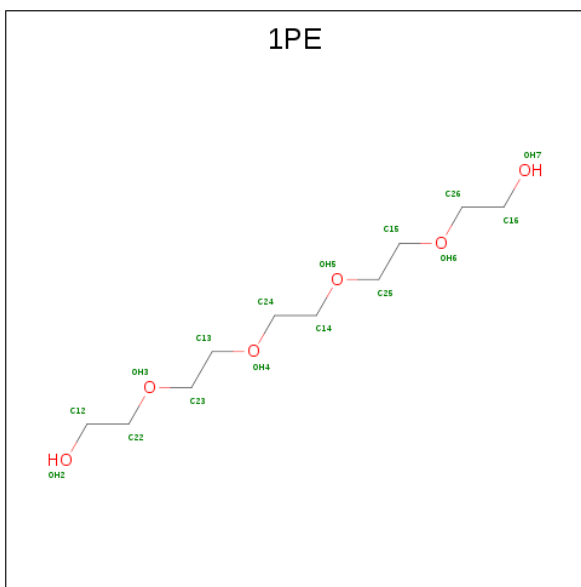
- Molecule 2 is a protein called NAD(P) transhydrogenase subunit beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	261	Total	C	N	O	S	0	1	0
			1911	1277	305	313	16			

There is a discrepancy between the modelled and reference sequences:

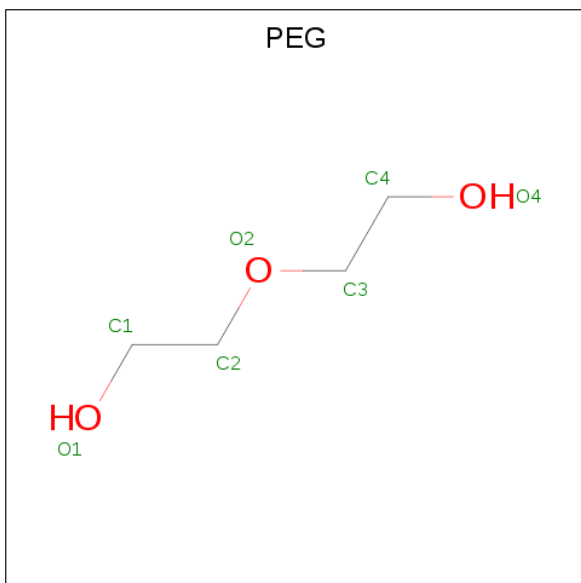
Chain	Residue	Modelled	Actual	Comment	Reference
B	258	ILE	-	insertion	UNP Q72GS0

- Molecule 3 is PENTAETHYLENE GLYCOL (three-letter code: 1PE) (formula: C₁₀H₂₂O₆).



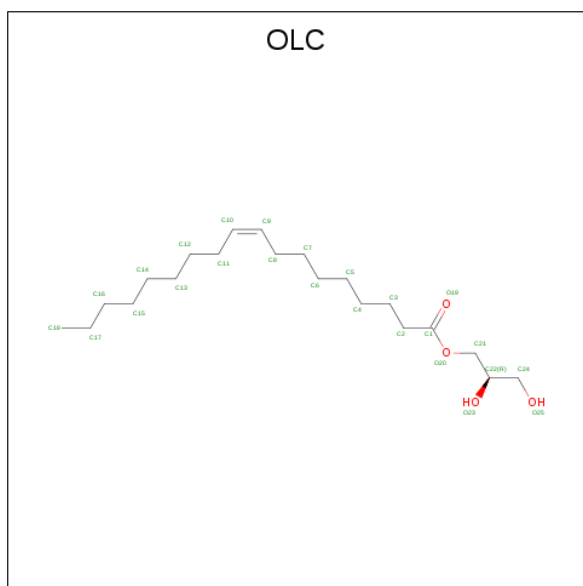
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			10	6	4		
3	A	1	Total	C	O	0	0
			10	6	4		
3	B	1	Total	C	O	0	0
			10	6	4		
3	B	1	Total	C	O	0	0
			10	6	4		

- Molecule 4 is DI(HYDROXYETHYL)ETHER (three-letter code: PEG) (formula: $C_4H_{10}O_3$).



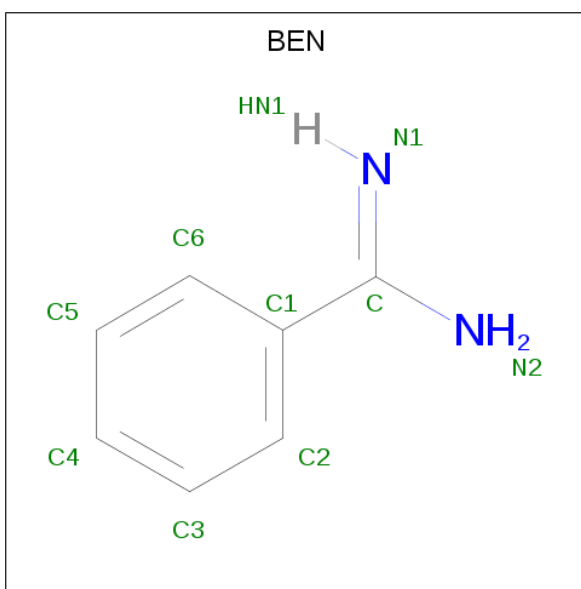
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total C O 7 4 3	0	0
4	A	1	Total C O 7 4 3	0	0
4	B	1	Total C O 7 4 3	0	0
4	B	1	Total C O 7 4 3	0	0
4	B	1	Total C O 7 4 3	0	0
4	B	1	Total C O 7 4 3	0	0
4	B	1	Total C O 4 2 2	0	0

- Molecule 5 is (2R)-2,3-dihydroxypropyl (9Z)-octadec-9-enoate (three-letter code: OLC) (formula: C₂₁H₄₀O₄).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	B	1	Total C O 23 19 4	0	0
5	B	1	Total C O 23 19 4	0	0

- Molecule 6 is BENZAMIDINE (three-letter code: BEN) (formula: C₇H₈N₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	B	1	Total	C	N	0	0
			9	7	2		
6	B	1	Total	C	N	0	0
			9	7	2		
6	B	1	Total	C	N	0	0
			9	7	2		

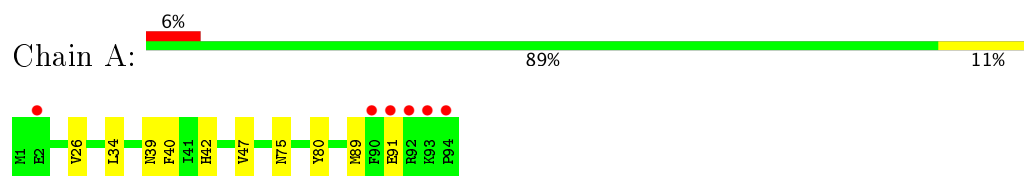
- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	10	Total	O	0	0
			10	10		
7	B	39	Total	O	0	0
			39	39		

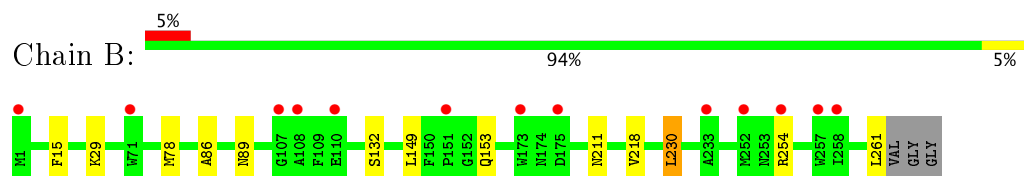
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: NAD(P) transhydrogenase subunit alpha 2



- Molecule 2: NAD(P) transhydrogenase subunit beta



4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	84.86Å 108.94Å 109.34Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	43.34 – 2.20 42.34 – 2.20	Depositor EDS
% Data completeness (in resolution range)	95.7 (43.34-2.20) 95.7 (42.34-2.20)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.97 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.8.0135	Depositor
R, R_{free}	0.186 , 0.223 0.197 , 0.229	Depositor DCC
R_{free} test set	1311 reflections (5.54%)	DCC
Wilson B-factor (Å ²)	39.2	Xtriage
Anisotropy	0.209	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 47.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	2829	wwPDB-VP
Average B, all atoms (Å ²)	46.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.59% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ 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: PEG, OLC, BEN, 1PE

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	0.93	0/727	0.89	0/986
2	B	0.91	1/1954 (0.1%)	0.87	3/2664 (0.1%)
All	All	0.91	1/2681 (0.0%)	0.88	3/3650 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	78	MET	C-O	5.14	1.33	1.23

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	230	LEU	CA-CB-CG	5.55	128.06	115.30
2	B	230	LEU	CB-CG-CD2	5.17	119.78	111.00
2	B	15	PHE	CB-CG-CD1	5.15	124.41	120.80

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	710	0	735	6	0
2	B	1911	0	2022	6	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	20	0	26	0	0
3	B	20	0	26	0	0
4	A	14	0	20	0	0
4	B	32	0	45	0	0
5	B	46	0	66	0	0
6	B	27	0	21	0	0
7	A	10	0	0	0	0
7	B	39	0	0	0	1
All	All	2829	0	2961	10	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 2.

All (10) 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:26:VAL:HG21	1:A:34:LEU:HD12	1.53	0.91
2:B:149:LEU:HA	2:B:153:GLN:HE22	1.68	0.57
1:A:39:ASN:HD22	1:A:42:HIS:CE1	2.31	0.48
1:A:39:ASN:HD21	2:B:89:ASN:HA	1.79	0.47
2:B:89:ASN:ND2	2:B:211:ASN:HA	2.33	0.44
1:A:39:ASN:ND2	1:A:42:HIS:CE1	2.86	0.44
1:A:91:GLU:OE2	2:B:29:LYS:NZ	2.50	0.43
2:B:86:ALA:O	2:B:132:SER:HB3	2.19	0.43
2:B:218:VAL:HG13	2:B:230:LEU:HD13	2.00	0.43
1:A:40:PHE:CE1	1:A:80:TYR:HB2	2.56	0.41

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)
7:B:415:HOH:O	7:B:415:HOH:O[4_575]	1.36	0.84

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	92/94 (98%)	85 (92%)	6 (6%)	1 (1%)	17	13
2	B	260/264 (98%)	256 (98%)	4 (2%)	0	100	100
All	All	352/358 (98%)	341 (97%)	10 (3%)	1 (0%)	44	49

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	89	MET

5.3.2 Protein sidechains ⓘ

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	73/74 (99%)	71 (97%)	2 (3%)	50	62
2	B	188/189 (100%)	186 (99%)	2 (1%)	78	88
All	All	261/263 (99%)	257 (98%)	4 (2%)	70	82

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	47	VAL
1	A	75	ASN
2	B	254	ARG
2	B	261	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	39	ASN
1	A	75	ASN

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Mol	Chain	Res	Type
2	B	54	ASN
2	B	89	ASN
2	B	153	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 carbohydrates in this entry.

5.6 Ligand geometry ⓘ

16 ligands are modelled in this entry.

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	1PE	A	101	-	9,9,15	0.96	0	8,8,14	1.13	1 (12%)
3	1PE	A	102	-	9,9,15	0.75	0	8,8,14	0.71	0
4	PEG	A	103	-	6,6,6	0.69	0	5,5,5	0.45	0
4	PEG	A	104	-	6,6,6	0.82	0	5,5,5	0.82	0
5	OLC	B	301	-	22,22,24	1.47	1 (4%)	23,23,25	1.75	4 (17%)
5	OLC	B	302	-	22,22,24	1.19	1 (4%)	23,23,25	1.42	3 (13%)
3	1PE	B	303	-	9,9,15	0.83	0	8,8,14	1.09	0
3	1PE	B	304	-	9,9,15	0.70	0	8,8,14	0.56	0
4	PEG	B	305	-	6,6,6	0.67	0	5,5,5	0.70	0
4	PEG	B	306	-	6,6,6	0.48	0	5,5,5	0.37	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
4	PEG	B	307	-	6,6,6	0.59	0	5,5,5	0.37	0
4	PEG	B	308	-	6,6,6	0.53	0	5,5,5	0.38	0
4	PEG	B	309	-	3,3,6	0.44	0	2,2,5	0.11	0
6	BEN	B	310	-	9,9,9	1.54	1 (11%)	9,11,11	0.90	1 (11%)
6	BEN	B	311	-	9,9,9	1.79	2 (22%)	9,11,11	1.59	1 (11%)
6	BEN	B	312	-	9,9,9	1.52	1 (11%)	9,11,11	0.45	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the chemical component dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	1PE	A	101	-	-	0/7/7/13	0/0/0/0
3	1PE	A	102	-	-	0/7/7/13	0/0/0/0
4	PEG	A	103	-	-	0/4/4/4	0/0/0/0
4	PEG	A	104	-	-	0/4/4/4	0/0/0/0
5	OLC	B	301	-	-	0/22/22/24	0/0/0/0
5	OLC	B	302	-	-	0/22/22/24	0/0/0/0
3	1PE	B	303	-	-	0/7/7/13	0/0/0/0
3	1PE	B	304	-	-	0/7/7/13	0/0/0/0
4	PEG	B	305	-	-	0/4/4/4	0/0/0/0
4	PEG	B	306	-	-	0/4/4/4	0/0/0/0
4	PEG	B	307	-	-	0/4/4/4	0/0/0/0
4	PEG	B	308	-	-	0/4/4/4	0/0/0/0
4	PEG	B	309	-	-	0/1/1/4	0/0/0/0
6	BEN	B	310	-	-	0/4/4/4	0/1/1/1
6	BEN	B	311	-	-	0/4/4/4	0/1/1/1
6	BEN	B	312	-	-	0/4/4/4	0/1/1/1

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	B	311	BEN	C2-C1	2.50	1.43	1.39
6	B	312	BEN	C1-C	3.10	1.52	1.47
6	B	310	BEN	C1-C	3.25	1.52	1.47
6	B	311	BEN	C1-C	4.11	1.54	1.47
5	B	302	OLC	O20-C1	4.39	1.46	1.33
5	B	301	OLC	O20-C1	5.57	1.49	1.33

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	B	302	OLC	O20-C1-O19	-3.78	114.16	123.55
5	B	301	OLC	O20-C1-O19	-3.33	115.28	123.55
5	B	301	OLC	C13-C12-C11	2.24	122.33	113.74
3	A	101	1PE	C24-OH4-C13	2.29	123.21	113.30
5	B	302	OLC	C21-O20-C1	2.33	124.15	117.13
6	B	310	BEN	C1-C-N2	2.50	121.95	118.12
5	B	301	OLC	C21-O20-C1	2.82	125.62	117.13
5	B	302	OLC	O20-C1-C2	4.05	123.68	111.90
6	B	311	BEN	C1-C-N2	4.28	124.69	118.12
5	B	301	OLC	O20-C1-C2	5.26	127.21	111.90

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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	94/94 (100%)	0.62	6 (6%) 20 19	29, 38, 96, 189	0
2	B	261/264 (98%)	-0.13	13 (4%) 30 28	27, 39, 67, 108	0
All	All	355/358 (99%)	0.07	19 (5%) 26 26	27, 39, 74, 189	0

All (19) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	94	PRO	21.3
1	A	93	LYS	14.6
1	A	91	GLU	10.9
1	A	92	ARG	9.0
2	B	257	TRP	6.4
2	B	173	TRP	4.9
2	B	258	ILE	3.7
2	B	107	GLY	3.6
2	B	151	PRO	3.5
2	B	252	MET	3.0
2	B	110	GLU	2.8
1	A	2	GLU	2.4
2	B	175	ASP	2.4
2	B	108	ALA	2.3
2	B	1	MET	2.3
2	B	254	ARG	2.3
1	A	90	PHE	2.2
2	B	71	TRP	2.1
2	B	233	ALA	2.1

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 carbohydrates 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å ²)	Q<0.9
5	OLC	B	302	23/25	0.67	0.30	10.36	48,77,88,97	0
4	PEG	B	309	4/7	0.90	0.24	7.71	65,65,65,66	0
6	BEN	B	311	9/9	0.71	0.25	6.39	72,83,90,90	0
4	PEG	B	308	7/7	0.82	0.23	4.76	66,74,84,87	0
3	1PE	A	101	10/16	0.89	0.28	4.47	47,55,61,62	0
4	PEG	A	103	7/7	0.75	0.20	3.56	66,73,76,78	0
4	PEG	A	104	7/7	0.80	0.21	3.08	57,60,68,71	0
5	OLC	B	301	23/25	0.69	0.26	2.79	56,70,87,93	0
6	BEN	B	312	9/9	0.79	0.36	2.55	63,69,70,76	0
3	1PE	B	303	10/16	0.82	0.18	1.29	61,67,76,78	0
3	1PE	A	102	10/16	0.89	0.17	0.54	52,58,62,67	0
3	1PE	B	304	10/16	0.91	0.12	-0.03	56,62,69,69	0
6	BEN	B	310	9/9	0.90	0.14	-0.15	61,66,73,75	0
4	PEG	B	307	7/7	0.84	0.20	-	75,80,85,89	0
4	PEG	B	305	7/7	0.80	0.18	-	64,68,84,85	0
4	PEG	B	306	7/7	0.91	0.10	-	56,61,69,71	0

6.5 Other polymers [i](#)

There are no such residues in this entry.