wwPDB X-ray Structure Validation Summary Report (i)

Feb 1, 2016 – 02:39 AM GMT

PDB ID	:	2I36
Title	:	Crystal structure of trigonal crystal form of ground-state rhodopsin
Authors	:	Stenkamp, R.E.; Le Trong, I.; Lodowski, D.T.; Salom, D.; Palczewski, K.
Deposited on	:	2006-08-17
Resolution	:	4.10 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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 (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

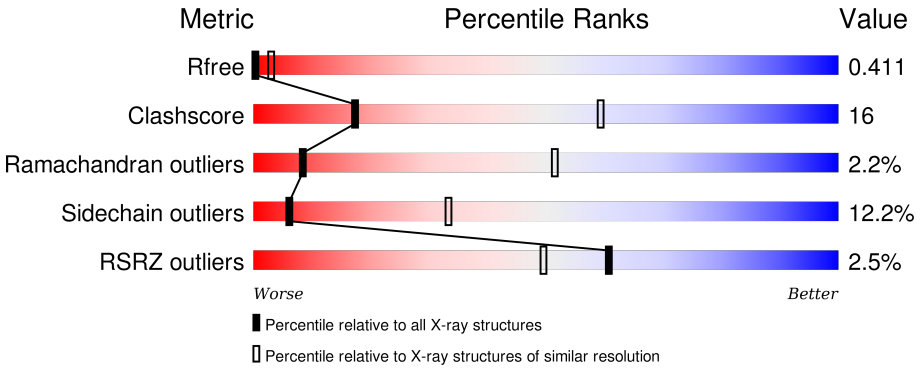
MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk26865

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 4.10 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}	91344	1018 (4.60-3.60)
Clashscore	102246	1117 (4.60-3.60)
Ramachandran outliers	100387	1063 (4.60-3.60)
Sidechain outliers	100360	1049 (4.60-3.60)
RSRZ outliers	91569	1022 (4.60-3.60)

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 <=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	349	2% 52% 36% 5% 6%
1	B	349	4% 50% 35% 5% 10%
1	C	349	% 53% 35% • 7%

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
4	PLM	A	401	-	-	-	X

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 7883 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 Rhodopsin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	327	Total	C	N	O	S	0	0	0
			2595	1727	400	442	26			
1	B	315	Total	C	N	O	S	0	0	0
			2502	1667	384	427	24			
1	C	323	Total	C	N	O	S	0	0	0
			2568	1712	394	437	25			

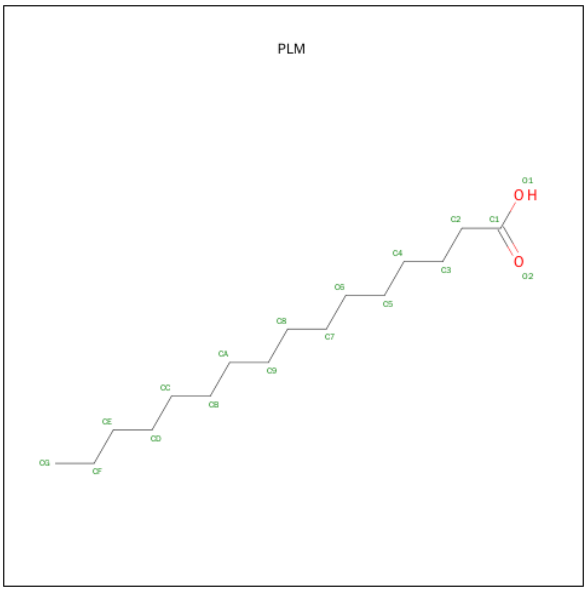
- Molecule 2 is a polymer of unknown type called SUGAR (3-MER).

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	3	Total	C	N	O	0	0
			39	22	2	15		
2	B	3	Total	C	N	O	0	0
			39	22	2	15		
2	C	3	Total	C	N	O	0	0
			39	22	2	15		

- Molecule 3 is a polymer of unknown type called SUGAR (2-MER).

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	2	Total	C	N	O	0	0
			28	16	2	10		
3	B	2	Total	C	N	O	0	0
			28	16	2	10		
3	C	2	Total	C	N	O	0	0
			28	16	2	10		

- Molecule 4 is PALMITIC ACID (three-letter code: PLM) (formula: $C_{16}H_{32}O_2$).



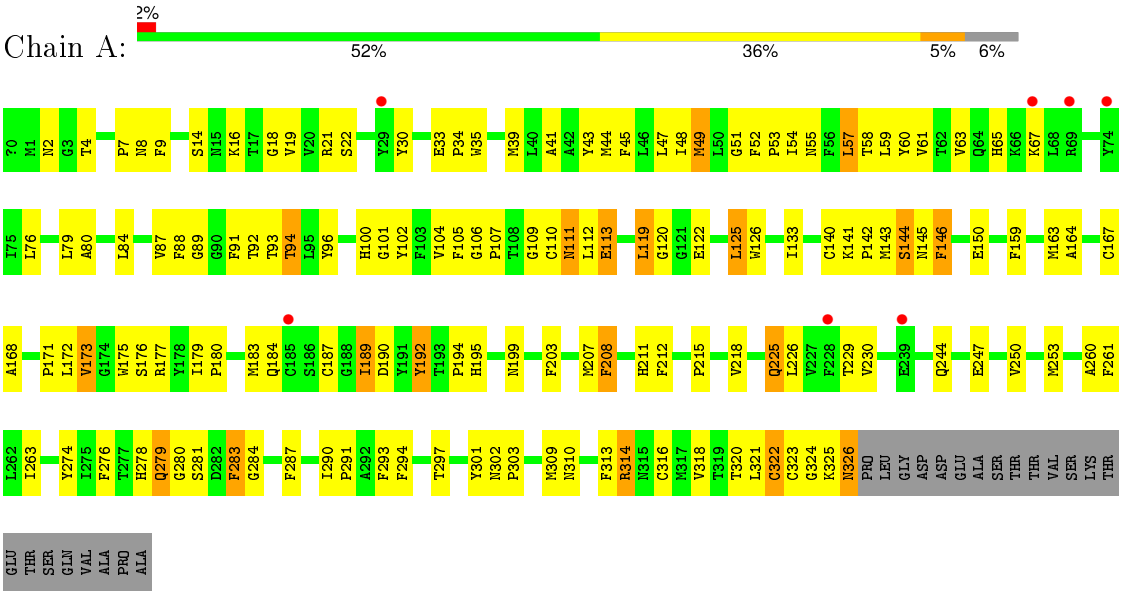
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total C O 17 16 1	0	0

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 errors 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.

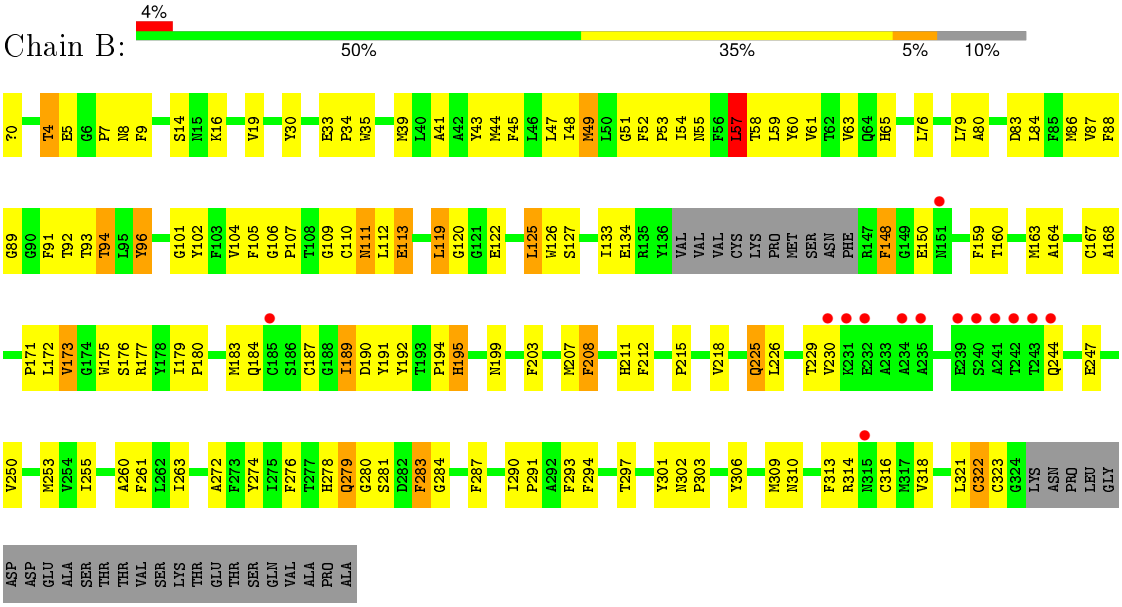
- Molecule 1: Rhodopsin

Chain A:



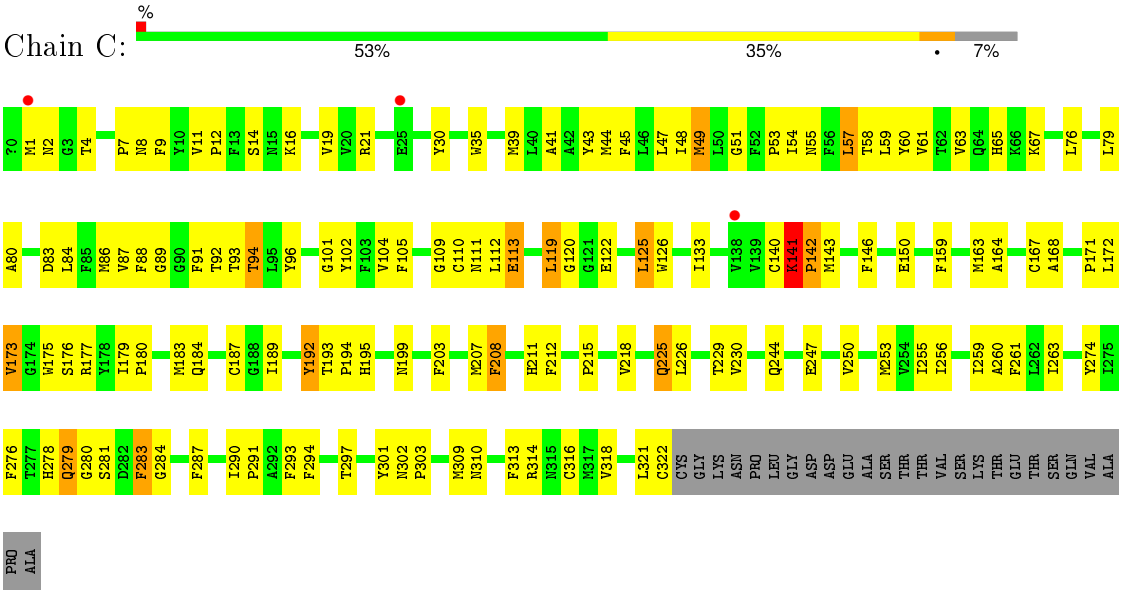
- Molecule 1: Rhodopsin

Chain B:



• Molecule 1: Rhodopsin

Chain C:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 31 1 2	Depositor
Cell constants a, b, c, α, β, γ	159.87Å 159.87Å 142.15Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	30.00 – 4.10 29.83 – 4.10	Depositor EDS
% Data completeness (in resolution range)	99.8 (30.00-4.10) 99.8 (29.83-4.10)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.52 (at 4.11Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.382 , 0.412 0.384 , 0.411	Depositor DCC
R_{free} test set	832 reflections (5.35%)	DCC
Wilson B-factor (Å^2)	200.1	Xtriage
Anisotropy	0.207	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.13 , -10.0	EDS
Estimated twinning fraction	0.069 for -h,-k,l	Xtriage
L-test for twinning[2]	$< \|L\| > = 0.44$, $< L^2 > = 0.27$	Xtriage
Outliers	0 of 16375 reflections	Xtriage
F_o,F_c correlation	0.86	EDS
Total number of atoms	7883	wwPDB-VP
Average B, all atoms (Å^2)	185.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.36% 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, 0.375 respectively for untwinned datasets, and 0.333, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: PLM, NAG, ACE, MAN

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	0.50	0/2675	0.59	0/3645
1	B	0.54	2/2579 (0.1%)	0.60	3/3514 (0.1%)
1	C	0.60	1/2648 (0.0%)	0.58	0/3610
All	All	0.55	3/7902 (0.0%)	0.59	3/10769 (0.0%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	141	LYS	CE-NZ	17.19	1.92	1.49
1	B	148	PHE	CG-CD2	7.43	1.50	1.38
1	B	148	PHE	CE1-CZ	5.81	1.48	1.37

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	148	PHE	CB-CG-CD1	-5.52	116.94	120.80
1	B	322	CYS	CA-C-N	-5.35	105.43	117.20
1	B	57	LEU	CA-CB-CG	5.14	127.13	115.30

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	2595	0	2569	87	0
1	B	2502	0	2469	85	0
1	C	2568	0	2543	85	0
2	A	39	0	34	1	0
2	B	39	0	34	5	0
2	C	39	0	34	2	0
3	A	28	0	25	1	0
3	B	28	0	25	0	0
3	C	28	0	25	1	0
4	A	17	0	31	0	0
All	All	7883	0	7789	252	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 16.

The worst 5 of 252 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:C:141:LYS:NZ	1:C:141:LYS:CE	1.92	1.29
1:A:179:ILE:HG13	1:A:180:PRO:HD2	1.54	0.88
2:B:505:NAG:H2	2:C:505:NAG:H83	1.60	0.84
1:C:179:ILE:HG13	1:C:180:PRO:HD2	1.63	0.81
1:B:179:ILE:HG13	1:B:180:PRO:HD2	1.65	0.78

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	325/349 (93%)	270 (83%)	47 (14%)	8 (2%)	7 48
1	B	311/349 (89%)	265 (85%)	40 (13%)	6 (2%)	10 54

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	C	321/349 (92%)	270 (84%)	44 (14%)	7 (2%)	8 51
All	All	957/1047 (91%)	805 (84%)	131 (14%)	21 (2%)	8 51

5 of 21 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	279	GLN
1	B	279	GLN
1	C	279	GLN
1	A	111	ASN
1	A	144	SER

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	278/296 (94%)	242 (87%)	36 (13%)	5 31
1	B	266/296 (90%)	235 (88%)	31 (12%)	7 35
1	C	275/296 (93%)	242 (88%)	33 (12%)	6 34
All	All	819/888 (92%)	719 (88%)	100 (12%)	6 33

5 of 100 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	96	TYR
1	B	183	MET
1	C	207	MET
1	B	113	GLU
1	B	150	GLU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 13 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	73	ASN
1	B	199	ASN
1	C	73	ASN
1	A	310	ASN
1	C	8	ASN

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)

15 carbohydrates 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	$\#\|Z\| > 2$
2	MAN	A	503	2	11,11,12	0.41	0	14,15,17	1.36	1 (7%)
2	NAG	A	504	2	14,14,15	0.82	0	15,19,21	1.25	1 (6%)
2	NAG	A	505	1,2	14,14,15	0.76	0	15,19,21	1.66	2 (13%)
3	NAG	A	704	3	14,14,15	0.80	1 (7%)	15,19,21	1.62	2 (13%)
3	NAG	A	705	1,3	14,14,15	0.60	0	15,19,21	1.60	2 (13%)
2	MAN	B	503	2	11,11,12	0.56	0	14,15,17	2.18	3 (21%)
2	NAG	B	504	2	14,14,15	0.47	0	15,19,21	1.40	2 (13%)
2	NAG	B	505	1,2	14,14,15	0.59	0	15,19,21	1.50	4 (26%)
3	NAG	B	704	3	14,14,15	0.68	1 (7%)	15,19,21	2.04	1 (6%)
3	NAG	B	705	1,3	14,14,15	0.59	0	15,19,21	1.71	3 (20%)
2	MAN	C	503	2	11,11,12	0.48	0	14,15,17	1.95	4 (28%)
2	NAG	C	504	2	14,14,15	0.49	0	15,19,21	1.80	1 (6%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
2	NAG	C	505	1,2	14,14,15	0.74	0	15,19,21	1.61	2 (13%)
3	NAG	C	704	3	14,14,15	0.66	1 (7%)	15,19,21	1.75	1 (6%)
3	NAG	C	705	1,3	14,14,15	0.62	0	15,19,21	2.17	4 (26%)

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
2	MAN	A	503	2	-	0/2/19/22	1/1/1/1
2	NAG	A	504	2	-	0/6/23/26	0/1/1/1
2	NAG	A	505	1,2	-	0/6/23/26	0/1/1/1
3	NAG	A	704	3	-	0/6/23/26	0/1/1/1
3	NAG	A	705	1,3	-	0/6/23/26	0/1/1/1
2	MAN	B	503	2	-	0/2/19/22	1/1/1/1
2	NAG	B	504	2	-	1/6/23/26	0/1/1/1
2	NAG	B	505	1,2	-	1/6/23/26	0/1/1/1
3	NAG	B	704	3	-	0/6/23/26	0/1/1/1
3	NAG	B	705	1,3	-	0/6/23/26	0/1/1/1
2	MAN	C	503	2	-	0/2/19/22	0/1/1/1
2	NAG	C	504	2	-	0/6/23/26	0/1/1/1
2	NAG	C	505	1,2	-	0/6/23/26	0/1/1/1
3	NAG	C	704	3	-	0/6/23/26	0/1/1/1
3	NAG	C	705	1,3	-	0/6/23/26	0/1/1/1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	704	NAG	C1-C2	2.06	1.55	1.52
3	B	704	NAG	C1-C2	2.09	1.55	1.52
3	A	704	NAG	C1-C2	2.26	1.55	1.52

The worst 5 of 33 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	505	NAG	C3-C2-N2	-2.41	104.78	110.56
3	C	705	NAG	O3-C3-C4	-2.14	105.51	110.34
2	C	503	MAN	C6-C5-C4	-2.10	107.84	113.02
3	B	705	NAG	O3-C3-C4	-2.04	105.75	110.34
3	A	705	NAG	O5-C5-C6	2.03	111.75	107.35

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	505	NAG	O7-C7-N2-C2
2	B	504	NAG	O7-C7-N2-C2

All (2) ring outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	503	MAN	C1-C2-C3-C4-C5-O5
2	A	503	MAN	C1-C2-C3-C4-C5-O5

6 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	505	NAG	1	0
3	A	705	NAG	1	0
2	B	504	NAG	2	0
2	B	505	NAG	4	0
2	C	505	NAG	2	0
3	C	705	NAG	1	0

5.6 Ligand geometry (i)

1 ligand is 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	$\#\|Z\| > 2$
4	PLM	A	401	1	16,16,17	0.29	0	14,15,17	0.68	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
4	PLM	A	401	1	-	0/13/14/15	0/0/0/0

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.

No monomer is involved in short contacts.

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	326/349 (93%)	-0.27	7 (2%) 67 56	185, 185, 185, 185	0
1	B	314/349 (89%)	-0.15	14 (4%) 37 28	185, 185, 185, 185	0
1	C	322/349 (92%)	-0.33	3 (0%) 85 79	185, 185, 185, 185	0
All	All	962/1047 (91%)	-0.25	24 (2%) 61 49	185, 185, 185, 185	0

The worst 5 of 24 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	239	GLU	4.5
1	B	243	THR	4.5
1	B	240	SER	4.2
1	B	232	GLU	4.0
1	B	244	GLN	3.7

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

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, 95^{th} 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
2	NAG	A	505	14/15	0.92	0.19	-0.72	185,185,185,185	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	LLDF	B-factors(Å^2)	Q<0.9
2	NAG	C	505	14/15	0.92	0.19	-0.89	185,185,185,185	0
2	NAG	B	505	14/15	0.97	0.19	-0.91	185,185,185,185	0
3	NAG	B	705	14/15	0.84	0.45	-	185,185,185,185	0
3	NAG	C	705	14/15	0.93	0.21	-	185,185,185,185	0
2	NAG	B	504	14/15	0.84	0.17	-	185,185,185,185	0
3	NAG	B	704	14/15	0.83	0.65	-	185,185,185,185	0
3	NAG	C	704	14/15	0.84	0.33	-	185,185,185,185	0
2	MAN	C	503	11/12	0.80	0.17	-	185,185,185,185	0
2	NAG	A	504	14/15	0.95	0.08	-	185,185,185,185	0
2	MAN	A	503	11/12	0.91	0.18	-	185,185,185,185	0
2	NAG	C	504	14/15	0.88	0.25	-	185,185,185,185	0
3	NAG	A	705	14/15	0.81	0.25	-	185,185,185,185	0
2	MAN	B	503	11/12	0.64	0.23	-	185,185,185,185	0
3	NAG	A	704	14/15	0.82	0.29	-	185,185,185,185	0

6.4 Ligands

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, 95^{th} 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
4	PLM	A	401	17/18	0.58	0.21	2.89	185,185,185,185	0

6.5 Other polymers

There are no such residues in this entry.