Full wwPDB X-ray Structure Validation Report (i)

Jun 17, 2024 – 01:16 AM EDT

PDB ID	:	2XU0
Title	:	Crystal structure of the NTS-DBL1(alpha-1) domain of the Plasmodium falciparum membrane protein 1 (PfEMP1) from the varO strain.
Authors	:	Juillerat, A.; Lewit-Bentley, A.; Guillotte, M.; Vigan-Womas, I.; Hessler, A.; Gangnard, S.; England, P.; Mercereau-Puijalon, O.; Bentley, G.A.
Deposited on	:	2010-10-14
Resolution	:	2.06 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:

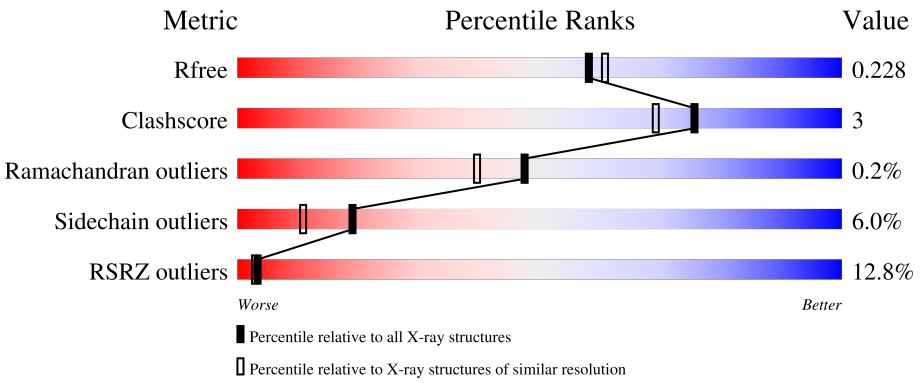
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.20.1
EDS	:	2.37.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.37.1

1 Overall quality at a glance (i)

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

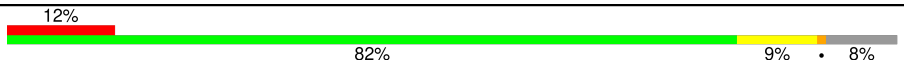
The reported resolution of this entry is 2.06 Å.

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	2684 (2.08-2.04)
Clashscore	141614	2801 (2.08-2.04)
Ramachandran outliers	138981	2768 (2.08-2.04)
Sidechain outliers	138945	2768 (2.08-2.04)
RSRZ outliers	127900	2646 (2.08-2.04)

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	487	

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	GOL	A	1489	-	X	-	-

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 3990 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.

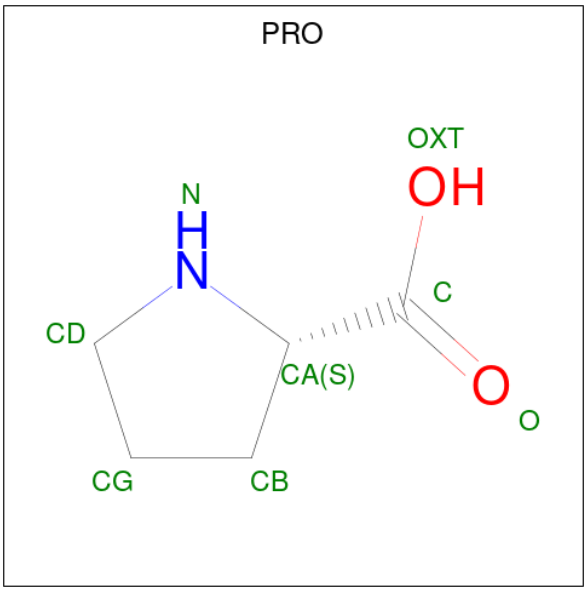
- Molecule 1 is a protein called ERYTHROCYTE MEMBRANE PROTEIN 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	447	3690	2300	664	703	23	0	10	0

There are 11 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	PHE	-	expression tag	UNP B7T1P0
A	10	ALA	THR	engineered mutation	UNP B7T1P0
A	66	ILE	GLY	engineered mutation	UNP B7T1P0
A	67	GLU	TYR	engineered mutation	UNP B7T1P0
A	68	GLY	VAL	engineered mutation	UNP B7T1P0
A	125	ALA	SER	engineered mutation	UNP B7T1P0
A	128	ALA	THR	engineered mutation	UNP B7T1P0
A	154	ALA	THR	engineered mutation	UNP B7T1P0
A	186	ALA	SER	engineered mutation	UNP B7T1P0
A	250	ALA	SER	engineered mutation	UNP B7T1P0
A	360	ALA	SER	engineered mutation	UNP B7T1P0

- Molecule 2 is PROLINE (three-letter code: PRO) (formula: $C_5H_9NO_2$).

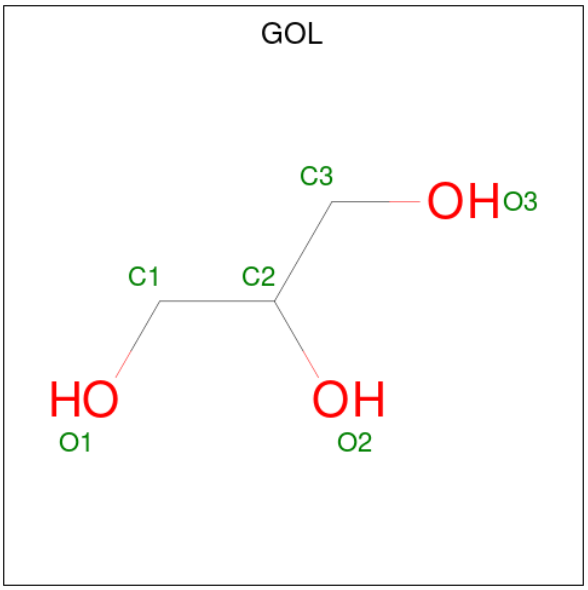


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
2	A	1	8	5	1	2	0	0

- Molecule 3 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mg		
3	A	1	1	1	0	0

- Molecule 4 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).



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

- Molecule 5 is water.

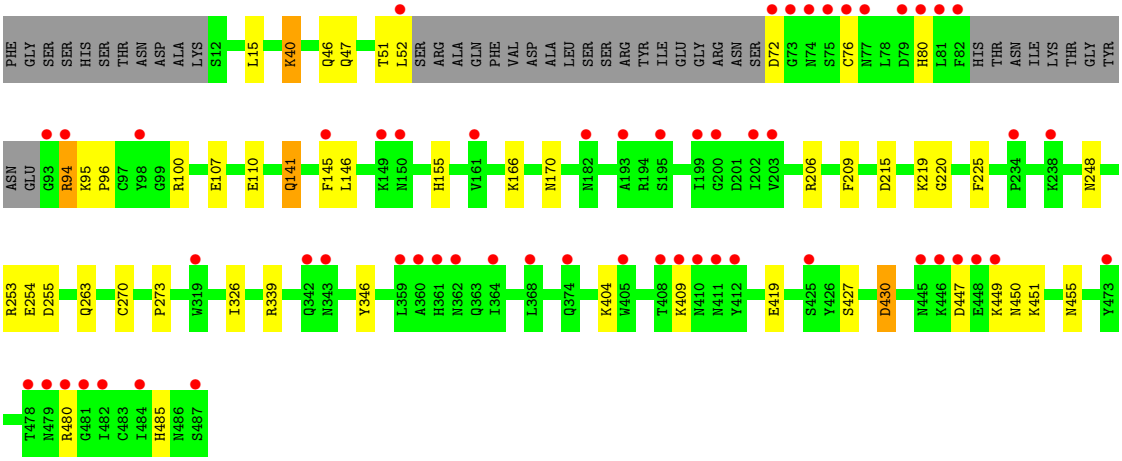
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
5	A	267	267	267	0	0

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: ERYTHROCYTE MEMBRANE PROTEIN 1

Chain A:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α, β, γ	93.25Å 93.25Å 126.98Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	28.72 – 2.06 27.92 – 2.06	Depositor EDS
% Data completeness (in resolution range)	99.2 (28.72-2.06) 99.2 (27.92-2.06)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.10 (at 2.06Å)	Xtriage
Refinement program	BUSTER 2.9.3	Depositor
R, R_{free}	0.182 , 0.216 0.191 , 0.228	Depositor DCC
R_{free} test set	1757 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å^2)	38.9	Xtriage
Anisotropy	0.001	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 64.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	3990	wwPDB-VP
Average B, all atoms (Å^2)	49.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.94% 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: MG, GOL

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	0.52	0/3832	0.66	0/5150

There are no bond length outliers.

There are no bond angle outliers.

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	3690	0	3537	23	0
2	A	8	0	7	0	0
3	A	1	0	0	0	0
4	A	24	0	32	2	0
5	A	267	0	0	5	0
All	All	3990	0	3576	23	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 3.

All (23) 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:51:THR:H	1:A:155:HIS:HD2	1.17	0.91
1:A:72:ASP:HB3	1:A:273:PRO:HB3	1.68	0.75
1:A:51:THR:H	1:A:155:HIS:CD2	2.06	0.71
1:A:94[B]:ARG:NH2	5:A:2033:HOH:O	2.24	0.69
1:A:404:LYS:NZ	5:A:2224:HOH:O	2.29	0.65
1:A:51:THR:N	1:A:155:HIS:HD2	1.95	0.56
1:A:430:ASP:HA	1:A:455:ASN:HD21	1.70	0.56
1:A:95:LYS:HG2	5:A:2036:HOH:O	2.09	0.51
1:A:76:CYS:HB3	1:A:166:LYS:HE2	1.94	0.49
1:A:76:CYS:SG	1:A:270[A]:CYS:HB3	2.52	0.48
1:A:94[C]:ARG:HG3	1:A:141:GLN:HE22	1.78	0.47
1:A:209:PHE:HZ	4:A:1491:GOL:H32	1.79	0.46
1:A:40:LYS:H	1:A:40:LYS:HD2	1.79	0.46
1:A:255:ASP:CG	4:A:1492:GOL:H12	2.36	0.46
1:A:225:PHE:CD2	1:A:253:ARG:HD3	2.51	0.45
1:A:220:GLY:HA3	5:A:2081:HOH:O	2.17	0.42
1:A:107:GLU:HA	1:A:326:ILE:HD12	2.01	0.42
1:A:263:GLN:HG2	5:A:2147:HOH:O	2.19	0.42
1:A:206:ARG:NH2	1:A:254:GLU:HG2	2.35	0.42
1:A:94[B]:ARG:NH1	1:A:94[B]:ARG:HG2	2.35	0.41
1:A:215:ASP:HB3	1:A:219:LYS:HE2	2.03	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	452/487 (93%)	438 (97%)	13 (3%)	1 (0%)	47 39

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	96	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	411/434 (95%)	382 (93%)	29 (7%)	14 7

All (29) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	15	LEU
1	A	40	LYS
1	A	47[A]	GLN
1	A	47[B]	GLN
1	A	52	LEU
1	A	80	HIS
1	A	94[A]	ARG
1	A	94[B]	ARG
1	A	94[C]	ARG
1	A	100	ARG
1	A	110[A]	GLU
1	A	110[B]	GLU
1	A	141	GLN
1	A	146	LEU
1	A	170	ASN
1	A	248	ASN
1	A	339	ARG
1	A	346	TYR
1	A	409	LYS
1	A	419[A]	GLU
1	A	419[B]	GLU
1	A	427	SER
1	A	430	ASP
1	A	447	ASP
1	A	449	LYS
1	A	450	ASN
1	A	451	LYS
1	A	480	ARG
1	A	485	HIS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (11) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	103	ASN
1	A	108	ASN
1	A	123	ASN
1	A	155	HIS
1	A	170	ASN
1	A	174	ASN
1	A	248	ASN
1	A	363	GLN
1	A	434	ASN
1	A	445	ASN
1	A	455	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)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 6 ligands modelled in this entry, 1 is monoatomic - leaving 5 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	$\#\|Z\| > 2$
2	PRO	A	1493	-	8,8,8	0.81	0	10,10,10	1.00	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
4	GOL	A	1492	-	5,5,5	0.56	0	5,5,5	0.67	0
4	GOL	A	1491	-	5,5,5	0.26	0	5,5,5	0.33	0
4	GOL	A	1489	-	5,5,5	1.36	1 (20%)	5,5,5	2.16	3 (60%)
4	GOL	A	1490	-	5,5,5	0.99	0	5,5,5	0.92	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
2	PRO	A	1493	-	-	1/4/11/11	0/1/1/1
4	GOL	A	1492	-	-	2/4/4/4	-
4	GOL	A	1491	-	-	4/4/4/4	-
4	GOL	A	1489	-	-	2/4/4/4	-
4	GOL	A	1490	-	-	3/4/4/4	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1489	GOL	C3-C2	2.16	1.60	1.51

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	1489	GOL	O3-C3-C2	2.89	123.41	110.38
4	A	1489	GOL	O1-C1-C2	2.76	122.80	110.38
4	A	1489	GOL	O2-C2-C3	2.17	118.18	109.18

There are no chirality outliers.

All (12) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	1489	GOL	C1-C2-C3-O3
4	A	1492	GOL	O1-C1-C2-O2
4	A	1490	GOL	C1-C2-C3-O3
4	A	1491	GOL	O1-C1-C2-C3
4	A	1491	GOL	C1-C2-C3-O3
4	A	1492	GOL	O1-C1-C2-C3
4	A	1489	GOL	O2-C2-C3-O3

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms
4	A	1490	GOL	O1-C1-C2-O2
4	A	1490	GOL	O2-C2-C3-O3
4	A	1491	GOL	O2-C2-C3-O3
4	A	1491	GOL	O1-C1-C2-O2
2	A	1493	PRO	O-C-CA-CB

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	1492	GOL	1	0
4	A	1491	GOL	1	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	447/487 (91%)	0.60	57 (12%) 3 3	25, 46, 82, 108	19 (4%)

All (57) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	81	LEU	11.9
1	A	73	GLY	7.4
1	A	72	ASP	7.3
1	A	479	ASN	7.1
1	A	80	HIS	6.9
1	A	449	LYS	6.4
1	A	480	ARG	6.3
1	A	448	GLU	5.9
1	A	409	LYS	5.6
1	A	79	ASP	5.5
1	A	93	GLY	5.4
1	A	76	CYS	5.3
1	A	410	ASN	5.1
1	A	481	GLY	4.7
1	A	75	SER	4.6
1	A	94[A]	ARG	4.6
1	A	482	ILE	4.3
1	A	487	SER	4.3
1	A	199	ILE	4.1
1	A	412	TYR	4.0
1	A	364	ILE	3.9
1	A	446	LYS	3.8
1	A	361	HIS	3.8
1	A	74	ASN	3.8
1	A	203	VAL	3.8
1	A	52	LEU	3.7
1	A	484	ILE	3.7

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	82	PHE	3.5
1	A	405	TRP	3.5
1	A	362	ASN	3.3
1	A	478	THR	3.2
1	A	149	LYS	3.0
1	A	408	THR	3.0
1	A	161	VAL	3.0
1	A	200	GLY	2.9
1	A	182	ASN	2.7
1	A	202	ILE	2.7
1	A	98	TYR	2.7
1	A	342	GLN	2.7
1	A	234	PRO	2.7
1	A	473	TYR	2.5
1	A	150	ASN	2.5
1	A	238	LYS	2.5
1	A	77	ASN	2.4
1	A	359	LEU	2.4
1	A	193	ALA	2.4
1	A	368	LEU	2.3
1	A	195	SER	2.3
1	A	360	ALA	2.3
1	A	319	TRP	2.3
1	A	447	ASP	2.2
1	A	411	ASN	2.1
1	A	343	ASN	2.1
1	A	445	ASN	2.1
1	A	145	PHE	2.1
1	A	425	SER	2.0
1	A	374	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
4	GOL	A	1490	6/6	0.65	0.25	65,67,68,68	0
4	GOL	A	1489	6/6	0.67	0.25	59,60,60,61	0
4	GOL	A	1491	6/6	0.73	0.28	62,64,65,67	5
4	GOL	A	1492	6/6	0.84	0.27	75,76,77,77	0
2	PRO	A	1493	8/8	0.94	0.10	34,41,46,46	0
3	MG	A	1488	1/1	0.96	0.14	48,48,48,48	0

6.5 Other polymers (i)

There are no such residues in this entry.