WORLDWIDE wwPDB PROTEIN DATA BANK

wwPDB X-ray Structure Validation Summary Report (i)

Aug 16, 2023 – 06:17 PM EDT

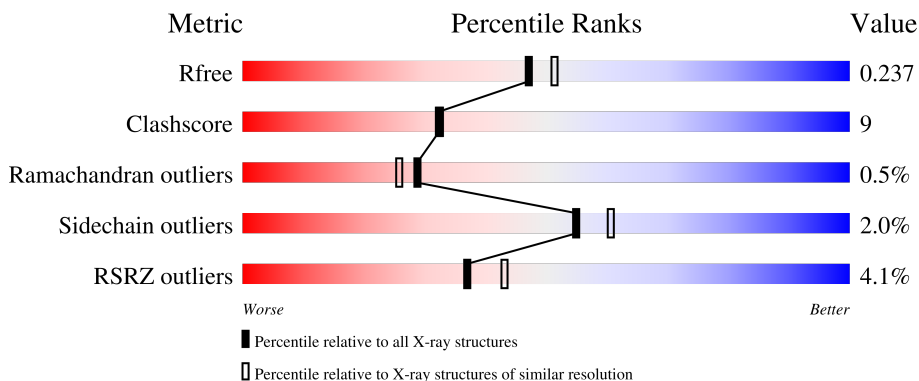|		
PDB ID	:	2F53
Title	:	Directed Evolution of Human T-cell Receptor CDR2 residues by phage display dramatically enhances affinity for cognate peptide-MHC without apparent cross-reactivity
Authors	:	Rizkallah, P.J.; Jakobsen, B.K.; Dunn, S.M.; Sami, M.
Deposited on	:	2005-11-25
Resolution	:	2.10 Å(reported)

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 2.10 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	Percentile Ranks	Value
Rfree		0.237
Clashscore		9
Ramachandran outliers		0.5%
Sidechain outliers		2.0%
RSRZ outliers		4.1%

Worse *Better*

▮ Percentile relative to all X-ray structures

◻ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	5197 (2.10-2.10)
Clashscore	141614	5710 (2.10-2.10)
Ramachandran outliers	138981	5647 (2.10-2.10)
Sidechain outliers	138945	5648 (2.10-2.10)
RSRZ outliers	127900	5083 (2.10-2.10)

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	275	4% / 88% 12%
2	B	100	% / 91% 8% •
3	C	9	11% / 100%
4	D	193	9% / 77% 21% •
5	E	243	2% / 81% 16% •

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
7	GOL	E	805	-	-	X	-

2 Entry composition ⓘ

There are 8 unique types of molecules in this entry. The entry contains 7335 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 HLA class I histocompatibility antigen.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	275	2259	1413	409	428	9	0	2	0

- Molecule 2 is a protein called Beta-2-microglobulin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	100	835	530	140	160	5	0	1	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	0	MET	-	cloning artifact	UNP P61769
B	91	CYS	LYS	engineered mutation	UNP P61769

- Molecule 3 is a protein called Cancer/testis antigen 1B.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	C	9	75	49	11	13	2	0	0	0

- Molecule 4 is a protein called T-cell Receptor, alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
4	D	193	1493	931	253	300	9	0	3	0

- Molecule 5 is a protein called T-cell receptor, beta chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
5	E	243	1920	1205	330	374	11	0	1	0

- Molecule 6 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	1	Total Na 1 1		0	0

- Molecule 7 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
7	A	1	Total C O 6 3 3			0	0
7	B	1	Total C O 6 3 3			0	0
7	B	1	Total C O 6 3 3			0	0
7	E	1	Total C O 6 3 3			0	0

- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	252	Total O 252 252		0	0
8	B	112	Total O 112 112		0	0
8	C	9	Total O 9 9		0	0
8	D	134	Total O 134 134		0	0

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| Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	E	221	Total 221	O 221	0	0

3 Residue-property plots ⓘ

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.
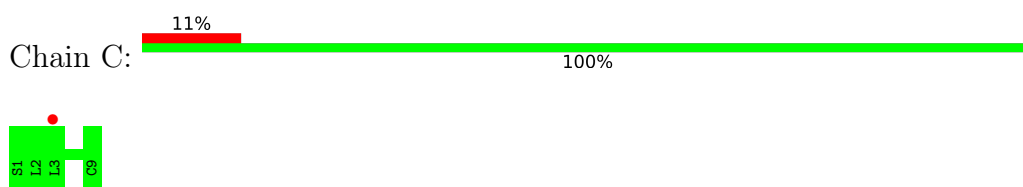
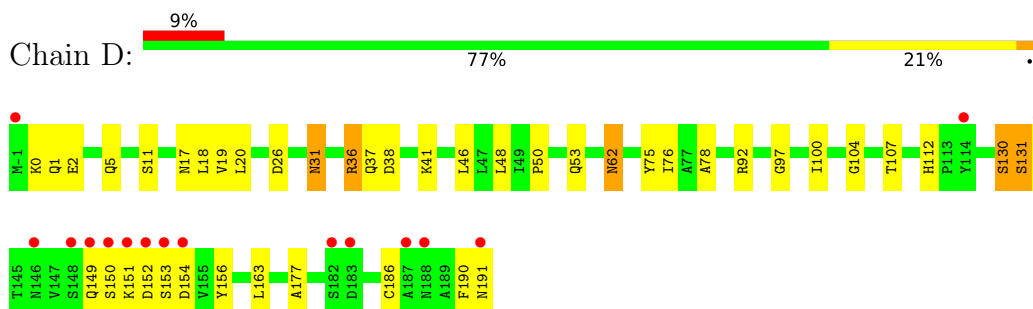• Molecule 1: HLA class I histocompatibility antigen
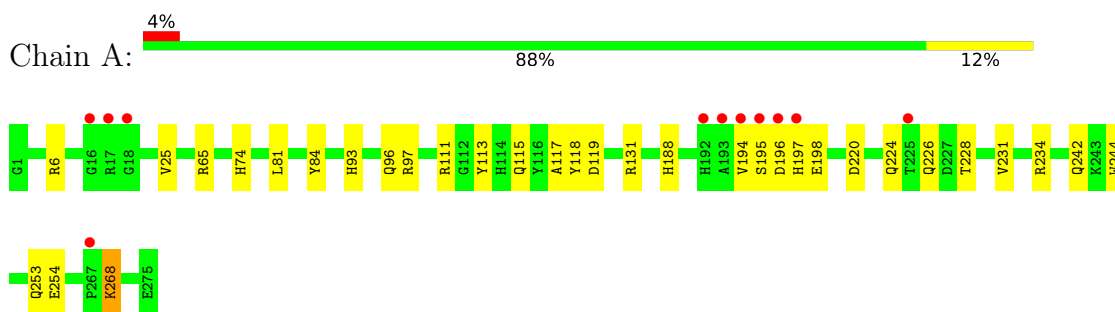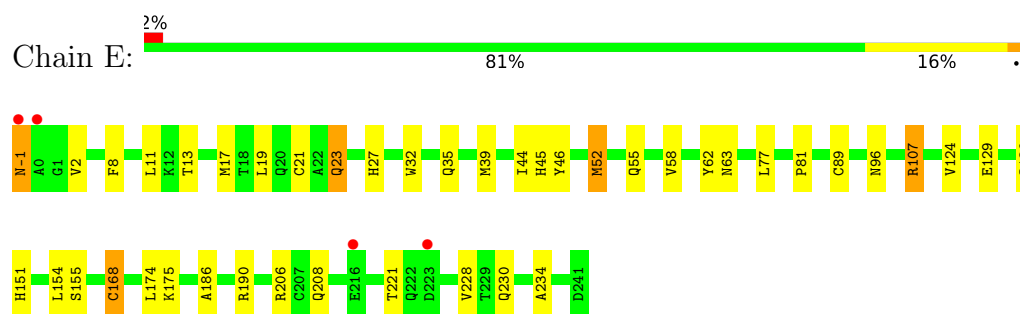

• Molecule 2: Beta-2-microglobulin
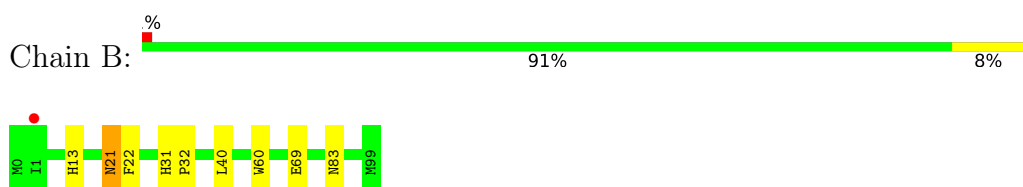
• Molecule 3: Cancer/testis antigen 1B

• Molecule 4: T-cell Receptor, alpha chain

• Molecule 5: T-cell receptor, beta chain

Chain E:

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	76.23Å 53.97Å 119.91Å 90.00° 96.83° 90.00°	Depositor
Resolution (Å)	37.85 – 2.10 37.85 – 1.99	Depositor EDS
% Data completeness (in resolution range)	98.7 (37.85-2.10) 97.5 (37.85-1.99)	Depositor EDS
R_{merge}	0.18	Depositor
R_{sym}	0.18	Depositor
$< I/\sigma(I) >$ [1]	1.57 (at 2.00Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.166 , 0.231 0.176 , 0.237	Depositor DCC
R_{free} test set	3285 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å^2)	29.4	Xtriage
Anisotropy	0.515	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 38.8	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	0.96	EDS
Total number of atoms	7335	wwPDB-VP
Average B, all atoms (Å^2)	16.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.66% 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 ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: NA, 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	0.66	0/2333	0.71	0/3167
2	B	0.71	0/863	0.81	0/1167
3	C	0.76	0/76	0.80	0/101
4	D	0.63	1/1541 (0.1%)	0.76	1/2093 (0.0%)
5	E	0.69	0/1976	0.72	0/2690
All	All	0.67	1/6789 (0.0%)	0.74	1/9218 (0.0%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	D	36	ARG	CB-CG	-6.75	1.34	1.52

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	D	36	ARG	NE-CZ-NH2	-6.75	116.93	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

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Mol	Chain	Res	Type	Group
1	A	84	TYR	Sidechain

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	2259	0	2107	28	0
2	B	835	0	796	9	0
3	C	75	0	79	0	0
4	D	1493	0	1438	47	0
5	E	1920	0	1814	36	0
6	A	1	0	0	0	0
7	A	6	0	8	0	0
7	B	12	0	16	0	0
7	E	6	0	8	4	0
8	A	252	0	0	7	0
8	B	112	0	0	1	0
8	C	9	0	0	0	0
8	D	134	0	0	1	0
8	E	221	0	0	5	0
All	All	7335	0	6266	112	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 9.

The worst 5 of 112 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:25:VAL:HB	8:B:825:HOH:O	1.31	1.23
4:D:130:SER:OG	4:D:131:SER:HA	1.60	1.02
4:D:1:GLN:HE22	4:D:26:ASP:H	1.14	0.95
4:D:37:GLN:HE22	5:E:35:GLN:HE22	1.15	0.89
2:B:21:ASN:HD22	2:B:22:PHE:H	1.25	0.85

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	275/275 (100%)	266 (97%)	9 (3%)	0	100	100
2	B	99/100 (99%)	97 (98%)	2 (2%)	0	100	100
3	C	7/9 (78%)	7 (100%)	0	0	100	100
4	D	194/193 (100%)	179 (92%)	11 (6%)	4 (2%)	7	3
5	E	242/243 (100%)	233 (96%)	9 (4%)	0	100	100
All	All	817/820 (100%)	782 (96%)	31 (4%)	4 (0%)	29	26

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
4	D	130	SER
4	D	150	SER
4	D	152	ASP
4	D	131	SER

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	233/231 (101%)	232 (100%)	1 (0%)	91	94
2	B	96/95 (101%)	93 (97%)	3 (3%)	40	43
3	C	9/9 (100%)	9 (100%)	0	100	100
4	D	172/169 (102%)	169 (98%)	3 (2%)	60	67

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
5	E	212/211 (100%)	205 (97%)	7 (3%)	38	40
All	All	722/715 (101%)	708 (98%)	14 (2%)	55	63

5 of 14 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
5	E	-1	ASN
5	E	23	GLN
5	E	190	ARG
5	E	107	ARG
5	E	168	CYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 46 such sidechains are listed below:

Mol	Chain	Res	Type
4	D	124	GLN
5	E	15	GLN
4	D	144	GLN
4	D	191	ASN
5	E	26	ASN

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 ⓘ

Of 5 ligands modelled in this entry, 1 is 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	$\#|Z| > 2$
7	GOL	A	803	-	5,5,5	0.43	0	5,5,5	0.13	0
7	GOL	B	802	-	5,5,5	0.41	0	5,5,5	0.45	0
7	GOL	B	804	-	5,5,5	0.43	0	5,5,5	0.18	0
7	GOL	E	805	-	5,5,5	0.79	0	5,5,5	0.83	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
7	GOL	A	803	-	-	2/4/4/4	-
7	GOL	B	802	-	-	1/4/4/4	-
7	GOL	B	804	-	-	4/4/4/4	-
7	GOL	E	805	-	-	2/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 9 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
7	A	803	GOL	O1-C1-C2-C3
7	B	804	GOL	C1-C2-C3-O3
7	B	804	GOL	O2-C2-C3-O3
7	E	805	GOL	O1-C1-C2-C3
7	A	803	GOL	O1-C1-C2-O2

There are no ring outliers.

1 monomer is involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
7	E	805	GOL	4	0

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, 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(Å²)	Q<0.9
1	A	275/275 (100%)	-0.03	11 (4%)	38	44	3, 12, 35, 63	0
2	B	100/100 (100%)	-0.29	1 (1%)	82	85	3, 11, 32, 66	0
3	C	9/9 (100%)	1.29	1 (11%)	5	7	2, 3, 6, 10	0
4	D	193/193 (100%)	0.35	17 (8%)	10	12	8, 20, 45, 59	0
5	E	243/243 (100%)	0.03	4 (1%)	72	75	2, 10, 26, 57	0
All	All	820/820 (100%)	0.06	34 (4%)	37	43	2, 13, 38, 66	0

The worst 5 of 34 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	1	ILE	6.1
1	A	194	VAL	5.0
4	D	183	ASP	5.0
4	D	150	SER	4.9
4	D	188	ASN	4.6

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 ⓘ

There are no monosaccharides in this entry.

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. 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
7	GOL	E	805	6/6	0.83	0.31	15,36,40,45	0
7	GOL	B	804	6/6	0.88	0.33	28,47,56,58	0
7	GOL	A	803	6/6	0.91	0.13	30,38,42,42	0
6	NA	A	801	1/1	0.95	0.20	27,27,27,27	0
7	GOL	B	802	6/6	0.95	0.32	9,10,25,54	0

6.5 Other polymers ⓘ

There are no such residues in this entry.