



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 06:54 AM UTC

PDB ID : 4MNQ / pdb_00004mnq
Title : TCR-peptide specificity overrides affinity enhancing TCR-MHC interactions
Authors : Rizkallah, P.J.; Cole, D.K.; Sewell, A.K.; Jakobsen, B.K.
Deposited on : 2013-09-11
Resolution : 2.74 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

<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	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

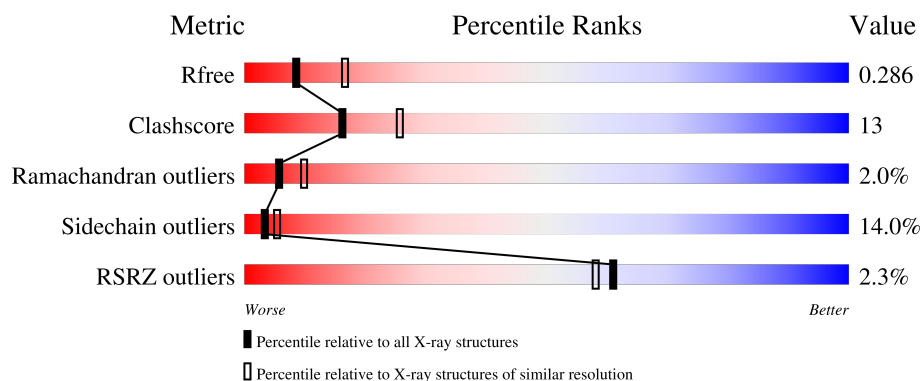
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.74 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}	180053	1819 (2.76-2.72)
Clashscore	190562	1866 (2.76-2.72)
Ramachandran outliers	187476	1830 (2.76-2.72)
Sidechain outliers	187428	1831 (2.76-2.72)
RSRZ outliers	180081	1819 (2.76-2.72)

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 $\leq 5\%$. 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	276	75% 21% .
2	B	100	% 73% 24% .
3	C	9	56% 44%
4	D	200	6% 52% 34% 11% .
5	E	240	2% 65% 30% 5%

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 6684 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, A-2 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	276	Total	C	N	O	S	0	0	0
			2254	1408	410	427	9			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	100	Total	C	N	O	S	0	0	0
			837	533	141	159	4			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	0	MET	-	expression tag	UNP P61769

- Molecule 3 is a protein called Telomerase reverse transcriptase.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	C	9	Total	C	N	O	0	0	0
			82	59	13	10			

- Molecule 4 is a protein called Uncharacterized protein, T-cell receptor, sp3.4 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	200	Total	C	N	O	S	0	0	0
			1565	985	258	315	7			

There are 26 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	27	ASP	ALA	conflict	UNP H2RG00
D	33	TRP	GLN	conflict	UNP H2RG00
D	89	VAL	-	linker	UNP H2RG00

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Chain	Residue	Modelled	Actual	Comment	Reference
D	90	ASP	-	linker	UNP H2RG00
D	91	SER	-	linker	UNP H2RG00
D	92	ALA	-	linker	UNP H2RG00
D	93	THR	-	linker	UNP H2RG00
D	94	ALA	-	linker	UNP H2RG00
D	95	LEU	-	linker	UNP H2RG00
D	96	PRO	-	linker	UNP H2RG00
D	97	TYR	-	linker	UNP H2RG00
D	98	GLY	-	linker	UNP H2RG00
D	99	TYR	-	linker	UNP H2RG00
D	100	ILE	-	linker	UNP H2RG00
D	101	PHE	-	linker	UNP H2RG00
D	102	GLY	-	linker	UNP H2RG00
D	103	THR	-	linker	UNP H2RG00
D	104	GLY	-	linker	UNP H2RG00
D	105	THR	-	linker	UNP H2RG00
D	106	ARG	-	linker	UNP H2RG00
D	107	LEU	-	linker	UNP H2RG00
D	108	LYS	-	linker	UNP H2RG00
D	109	VAL	-	linker	UNP H2RG00
D	110	LEU	-	linker	UNP H2RG00
D	111	ALA	-	linker	UNP H2RG00
D	112	ASN	-	linker	UNP H2RG00

- Molecule 5 is a protein called V_segment translation product, T-cell receptor beta-1 chain C region.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	E	240	Total	C	N	O	S	0	0	0
			1911	1203	329	370	9			

There are 26 discrepancies between the modelled and reference sequences:

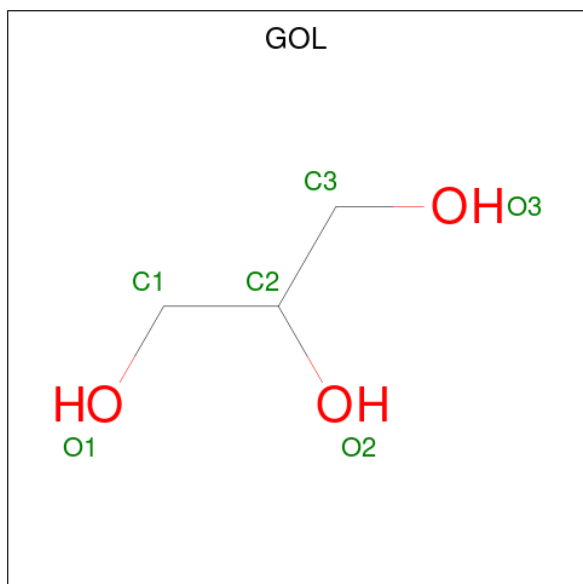
Chain	Residue	Modelled	Actual	Comment	Reference
E	50	ILE	VAL	conflict	UNP A0A585
E	51	HIS	GLY	conflict	UNP A0A585
E	52	PRO	ALA	conflict	UNP A0A585
E	53	GLU	GLY	conflict	UNP A0A585
E	54	TYR	ILE	conflict	UNP A0A585
E	96	GLN	-	linker	UNP A0A585
E	97	GLY	-	linker	UNP A0A585
E	98	THR	-	linker	UNP A0A585

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Chain	Residue	Modelled	Actual	Comment	Reference
E	99	GLU	-	linker	UNP A0A585
E	100	ALA	-	linker	UNP A0A585
E	101	PHE	-	linker	UNP A0A585
E	102	PHE	-	linker	UNP A0A585
E	103	GLY	-	linker	UNP A0A585
E	104	GLN	-	linker	UNP A0A585
E	105	GLY	-	linker	UNP A0A585
E	106	THR	-	linker	UNP A0A585
E	107	ARG	-	linker	UNP A0A585
E	108	LEU	-	linker	UNP A0A585
E	109	THR	-	linker	UNP A0A585
E	110	VAL	-	linker	UNP A0A585
E	111	VAL	-	linker	UNP A0A585
E	112	GLU	-	linker	UNP A0A585
E	148	TYR	PHE	conflict	UNP P01850
E	168	CYS	SER	conflict	UNP P01850
E	186	ALA	CYS	conflict	UNP P01850
E	200	ASP	ASN	conflict	UNP P01850

- Molecule 6 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



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

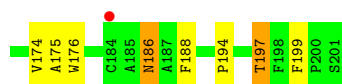
- Molecule 7 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: $C_2H_6O_2$).



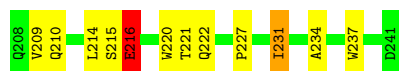
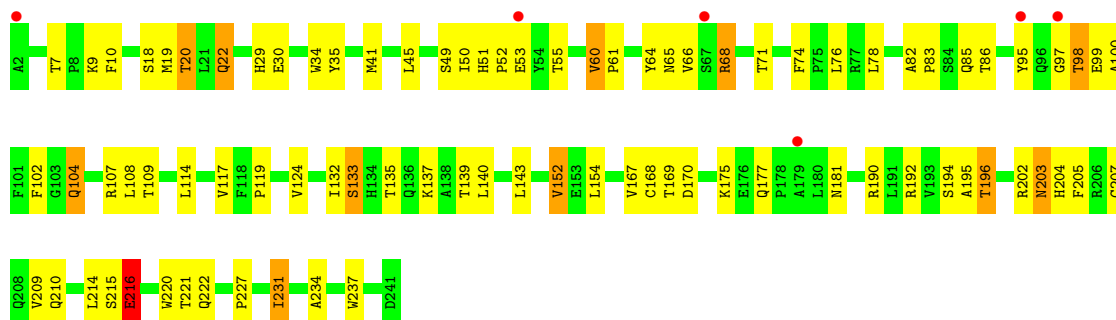
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
7	A	1	Total	C	O	0	0
			4	2	2		
7	E	1	Total	C	O	0	0
			4	2	2		

- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	11	Total	O	0	0
			11	11		
8	B	5	Total	O	0	0
			5	5		
8	D	2	Total	O	0	0
			2	2		
8	E	3	Total	O	0	0
			3	3		



- Molecule 5: V_segment translation product, T-cell receptor beta-1 chain C region



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	94.22Å 48.49Å 118.07Å 90.00° 107.86° 90.00°	Depositor
Resolution (Å)	42.15 – 2.74 42.15 – 2.74	Depositor EDS
% Data completeness (in resolution range)	97.7 (42.15-2.74) 97.7 (42.15-2.74)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.04 (at 2.73Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.214 , 0.284 0.217 , 0.286	Depositor DCC
R_{free} test set	1344 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	59.1	Xtriage
Anisotropy	0.290	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.30 , 41.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	6684	wwPDB-VP
Average B, all atoms (Å ²)	65.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.32% 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: EDO, 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	0.86	0/2320	1.00	7/3149 (0.2%)
2	B	0.87	0/860	0.96	2/1162 (0.2%)
3	C	0.78	0/85	0.63	0/113
4	D	0.80	2/1602 (0.1%)	1.04	10/2183 (0.5%)
5	E	0.71	0/1965	0.93	2/2679 (0.1%)
All	All	0.81	2/6832 (0.0%)	0.98	21/9286 (0.2%)

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
4	D	0	2

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	D	27	ASP	N-CA	6.18	1.54	1.46
4	D	28	SER	N-CA	5.47	1.52	1.46

The worst 5 of 21 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	D	28	SER	N-CA-C	10.02	126.51	108.48
4	D	7	SER	CA-C-N	-9.80	110.28	120.38
4	D	7	SER	C-N-CA	-9.80	110.28	120.38
1	A	206	LEU	N-CA-C	8.17	123.73	113.43
5	E	18	SER	N-CA-C	7.64	120.53	109.14

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
4	D	47	PHE	Peptide
4	D	65	ALA	Peptide

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	2254	0	2103	33	0
2	B	837	0	803	20	0
3	C	82	0	90	4	0
4	D	1565	0	1480	73	0
5	E	1911	0	1796	52	0
6	A	6	0	8	0	0
7	A	4	0	6	0	0
7	E	4	0	6	0	0
8	A	11	0	0	1	0
8	B	5	0	0	0	0
8	D	2	0	0	4	0
8	E	3	0	0	0	0
All	All	6684	0	6292	170	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 13.

The worst 5 of 170 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)
8:A:411:HOH:O	4:D:27:ASP:HB2	1.71	0.89
4:D:67:GLU:HA	8:D:402:HOH:O	1.74	0.86
4:D:49:ILE:O	4:D:64:VAL:HG21	1.79	0.81
4:D:67:GLU:CA	8:D:402:HOH:O	2.29	0.77
4:D:51:SER:O	4:D:53:THR:N	2.18	0.77

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	274/276 (99%)	254 (93%)	18 (7%)	2 (1%)	18	32
2	B	98/100 (98%)	94 (96%)	4 (4%)	0	100	100
3	C	7/9 (78%)	4 (57%)	3 (43%)	0	100	100
4	D	198/200 (99%)	167 (84%)	18 (9%)	13 (7%)	1	1
5	E	238/240 (99%)	212 (89%)	25 (10%)	1 (0%)	30	47
All	All	815/825 (99%)	731 (90%)	68 (8%)	16 (2%)	6	10

5 of 16 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
4	D	7	SER
4	D	27	ASP
4	D	52	GLY
4	D	66	THR
4	D	46	LEU

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	232/232 (100%)	209 (90%)	23 (10%)	7	14
2	B	95/95 (100%)	86 (90%)	9 (10%)	8	15
3	C	8/8 (100%)	8 (100%)	0	100	100
4	D	179/179 (100%)	141 (79%)	38 (21%)	1	1

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
5	E	209/209 (100%)	178 (85%)	31 (15%)	3	4
All	All	723/723 (100%)	622 (86%)	101 (14%)	3	5

5 of 101 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	D	105	THR
5	E	22	GLN
5	E	222	GLN
4	D	112	ASN
4	D	153	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 31 such sidechains are listed below:

Mol	Chain	Res	Type
4	D	36	HIS
5	E	134	HIS
4	D	78	GLN
5	E	203	ASN
4	D	190	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

3 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	$\# Z > 2$
7	EDO	E	301	-	3,3,3	0.41	0	2,2,2	0.31	0
7	EDO	A	302	-	3,3,3	0.52	0	2,2,2	0.43	0
6	GOL	A	301	-	5,5,5	0.42	0	5,5,5	0.24	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	EDO	E	301	-	-	1/1/1/1	-
7	EDO	A	302	-	-	1/1/1/1	-
6	GOL	A	301	-	-	4/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 6 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	301	GOL	O1-C1-C2-O2
6	A	301	GOL	O1-C1-C2-C3
6	A	301	GOL	C1-C2-C3-O3
6	A	301	GOL	O2-C2-C3-O3
7	E	301	EDO	O1-C1-C2-O2

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 [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	276/276 (100%)	0.04	0 100 100	27, 56, 101, 119	0
2	B	100/100 (100%)	-0.09	1 (1%) 79 79	26, 47, 75, 95	0
3	C	9/9 (100%)	-0.09	0 100 100	42, 46, 51, 54	0
4	D	200/200 (100%)	0.61	12 (6%) 27 27	42, 76, 110, 123	0
5	E	240/240 (100%)	0.19	6 (2%) 58 55	35, 68, 112, 129	0
All	All	825/825 (100%)	0.20	19 (2%) 61 58	26, 63, 107, 129	0

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	D	52	GLY	6.1
4	D	38	ASN	4.6
4	D	40	TRP	3.5
4	D	2	ILE	2.7
4	D	51	SER	2.7

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 oligosaccharides 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
7	EDO	A	302	4/4	0.68	0.15	59,65,67,68	0
7	EDO	E	301	4/4	0.78	0.16	61,61,65,70	0
6	GOL	A	301	6/6	0.86	0.10	70,73,75,78	0

6.5 Other polymers [i](#)

There are no such residues in this entry.