Full wwPDB X-ray Structure Validation Report ⓘ

Jan 27, 2025 – 12:17 PM EST

PDB ID	:	9DQ4
Title	:	Crystal structure of engineered Ipilimumab (mipi.4) Fab in complex with mouse CTLA-4
Authors	:	Diong, S.J.; Lee, P.S.
Deposited on	:	2024-09-23
Resolution	:	1.57 Å(reported)

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

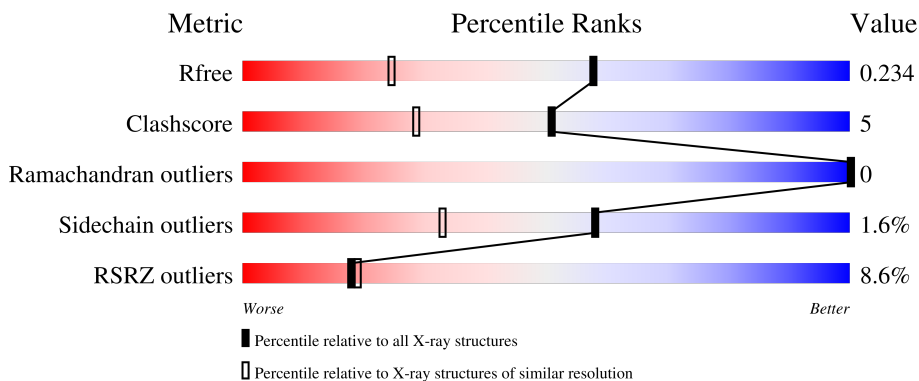|		
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.21
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.004 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.40

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 1.57 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		0.234
Clashscore		5
Ramachandran outliers		0
Sidechain outliers		1.6%
RSRZ outliers		8.6%

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}	164625	7165 (1.60-1.56)
Clashscore	180529	1026 (1.58-1.58)
Ramachandran outliers	177936	1005 (1.58-1.58)
Sidechain outliers	177891	1004 (1.58-1.58)
RSRZ outliers	164620	7163 (1.60-1.56)

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	125	10% 74% 12% · 14%
2	H	229	6% 89% · 7%
3	L	215	9% 87% 11% ··
4	B	4	25% 75%

2 Entity composition ⓘ

There are 5 unique types of molecules in this entry. The entry contains 8227 atoms, of which 3749 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 Cytotoxic T-lymphocyte protein 4.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	108	Total	C	H	N	O	S	0	0	0
			1572	528	747	133	157	7			

There are 7 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	117	GLY	-	expression tag	UNP P09793
A	118	HIS	-	expression tag	UNP P09793
A	119	HIS	-	expression tag	UNP P09793
A	120	HIS	-	expression tag	UNP P09793
A	121	HIS	-	expression tag	UNP P09793
A	122	HIS	-	expression tag	UNP P09793
A	123	HIS	-	expression tag	UNP P09793

- Molecule 2 is a protein called mipi.4 heavy chain.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
2	H	212	Total	C	H	N	O	S	0	0	0
			3084	1011	1499	267	301	6			

- Molecule 3 is a protein called mipi.4 light chain.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
3	L	213	Total	C	H	N	O	S	0	0	0
			3127	1024	1503	273	323	4			

- Molecule 4 is an oligosaccharide called beta-D-mannopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-[alpha-L-fucopyranose-(1-6)]2-acetamido-2-deoxy-beta-D-glucopyranose.
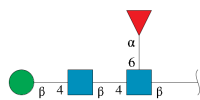
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
4	B	4	Total	C	N	O	0	0	0
			49	28	2	19			

• Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	64	Total	O	0	0
			64	64		
5	H	154	Total	O	0	0
			154	154		
5	L	177	Total	O	0	0
			177	177		

3 Residue-property plots ⓘ

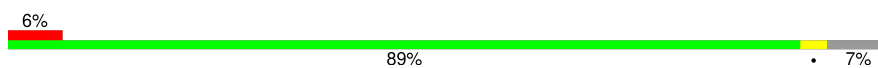These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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.

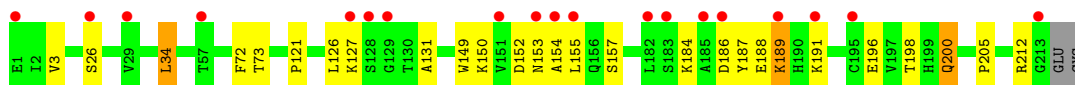• Molecule 1: Cytotoxic T-lymphocyte protein 4

Chain A:
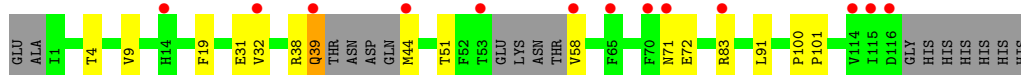
• Molecule 2: mipi.4 heavy chain

Chain H:

• Molecule 3: mipi.4 light chain

Chain L:

• Molecule 4: beta-D-mannopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-[alpha-L-fucopyranose-(1-6)]2-acetamido-2-deoxy-beta-D-glucopyranose

Chain B:

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α, β, γ	82.31Å 152.78Å 48.01Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	40.02 – 1.57 40.02 – 1.57	Depositor EDS
% Data completeness (in resolution range)	78.9 (40.02-1.57) 79.5 (40.02-1.57)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.75 (at 1.57Å)	Xtriage
Refinement program	PHENIX (1.20.1_4487: ???)	Depositor
R, R_{free}	0.205 , 0.233 0.207 , 0.234	Depositor DCC
R_{free} test set	4317 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å^2)	17.6	Xtriage
Anisotropy	0.049	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.38 , 33.8	EDS
L-test for twinning[2]	$< |L| > = 0.50, < L^2 > = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	8227	wwPDB-VP
Average B, all atoms (Å^2)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.76% of the height of the origin peak. No significant pseudotranslation is detected.*

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[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: FUC, NAG, BMA

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	0.64	0/843	0.75	0/1150
2	H	0.64	1/1627 (0.1%)	0.81	1/2222 (0.0%)
3	L	0.59	0/1664	0.78	2/2266 (0.1%)
All	All	0.62	1/4134 (0.0%)	0.79	3/5638 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	H	186	VAL	CB-CG1	-7.04	1.38	1.52

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	L	34	LEU	CB-CG-CD1	5.43	120.23	111.00
3	L	200	GLN	CA-CB-CG	-5.24	101.87	113.40
2	H	62	ASP	CB-CG-OD1	5.07	122.86	118.30

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	825	747	797	17	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	H	1585	1499	1518	5	0
3	L	1624	1503	1554	18	0
4	B	49	0	43	3	0
5	A	64	0	0	0	1
5	H	154	0	0	0	0
5	L	177	0	0	2	1
All	All	4478	3749	3912	41	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 5.

All (41) 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:39:GLN:HG3	1:A:44:MET:HE1	1.61	0.81
1:A:39:GLN:HG3	1:A:44:MET:CE	2.14	0.77
3:L:34:LEU:HD13	3:L:72:PHE:CD2	2.20	0.76
1:A:39:GLN:NE2	1:A:91:LEU:HD11	2.11	0.66
2:H:218:PRO:O	2:H:219:LYS:HB3	1.97	0.65
3:L:200:GLN:O	3:L:200:GLN:HG3	1.96	0.64
1:A:39:GLN:HE21	1:A:91:LEU:HD11	1.65	0.60
4:B:2:NAG:O3	4:B:3:BMA:H2	2.01	0.59
3:L:152:ASP:OD1	3:L:191:LYS:HE2	2.02	0.59
1:A:4:THR:HG22	4:B:1:NAG:H81	1.86	0.57
1:A:58:VAL:O	1:A:58:VAL:HG13	2.06	0.56
4:B:2:NAG:C3	4:B:3:BMA:H2	2.37	0.54
1:A:31:GLU:OE2	2:H:56:ARG:NH2	2.40	0.50
3:L:73:THR:HG22	5:L:301:HOH:O	2.12	0.50
1:A:83:ARG:HG3	1:A:83:ARG:NH1	2.28	0.48
3:L:187:TYR:CZ	3:L:212:ARG:HG3	2.48	0.48
1:A:9:VAL:HG11	1:A:19:PHE:HB3	1.95	0.48
1:A:83:ARG:HG3	1:A:83:ARG:HH11	1.77	0.48
3:L:149:TRP:O	3:L:155:LEU:HD12	2.13	0.48
3:L:184:LYS:O	3:L:188:GLU:HG3	2.14	0.47
1:A:39:GLN:CG	1:A:44:MET:HE1	2.39	0.47
3:L:198:THR:HG22	3:L:205:PRO:HG3	1.96	0.47
1:A:39:GLN:HG3	1:A:44:MET:SD	2.55	0.46
3:L:152:ASP:O	3:L:153:ASN:CB	2.65	0.45
3:L:3:VAL:HB	3:L:26:SER:OG	2.18	0.44
3:L:187:TYR:CE2	3:L:212:ARG:HG3	2.53	0.43
3:L:150:LYS:HA	3:L:154:ALA:O	2.20	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:100:PRO:HA	1:A:101:PRO:C	2.39	0.42
1:A:31:GLU:HG3	1:A:51:THR:CG2	2.50	0.42
3:L:126:LEU:HD21	3:L:131:ALA:HB2	2.01	0.41
1:A:31:GLU:HG3	1:A:51:THR:HG23	2.02	0.41
1:A:39:GLN:HE21	1:A:44:MET:HE3	1.85	0.41
1:A:71:ASN:O	1:A:72:GLU:HB2	2.20	0.41
3:L:150:LYS:NZ	3:L:196:GLU:OE1	2.51	0.41
3:L:121:PRO:HG3	3:L:131:ALA:HB1	2.01	0.41
2:H:183:LEU:HD12	2:H:183:LEU:C	2.41	0.41
3:L:34:LEU:HD13	3:L:72:PHE:CG	2.55	0.41
2:H:148:LYS:HE2	5:L:304:HOH:O	2.21	0.40
2:H:169:HIS:O	2:H:186:VAL:HG22	2.21	0.40
3:L:127:LYS:HB2	3:L:127:LYS:HE2	1.71	0.40
3:L:189:LYS:HB3	3:L:189:LYS:HE2	1.91	0.40

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)
5:A:203:HOH:O	5:L:323:HOH:O[1_554]	2.13	0.07

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	102/125 (82%)	101 (99%)	1 (1%)	0	100	100
2	H	208/229 (91%)	204 (98%)	4 (2%)	0	100	100
3	L	211/215 (98%)	204 (97%)	7 (3%)	0	100	100
All	All	521/569 (92%)	509 (98%)	12 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	94/111 (85%)	91 (97%)	3 (3%)	34	7
2	H	168/192 (88%)	167 (99%)	1 (1%)	84	73
3	L	178/186 (96%)	175 (98%)	3 (2%)	56	29
All	All	440/489 (90%)	433 (98%)	7 (2%)	58	33

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	32	VAL
1	A	38	ARG
1	A	39	GLN
2	H	217	GLU
3	L	157	SER
3	L	186	ASP
3	L	189	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	39	GLN
2	H	204	ASN
3	L	27	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 ⓘ

4 monosaccharides 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	#$|Z| > 2$
4	NAG	B	1	1,4	14,14,15	0.86	1 (7%)	17,19,21	0.55	0
4	NAG	B	2	4	14,14,15	0.75	0	17,19,21	0.94	1 (5%)
4	BMA	B	3	4	11,11,12	1.02	0	15,15,17	1.04	1 (6%)
4	FUC	B	4	4	10,10,11	1.43	2 (20%)	14,14,16	0.85	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	NAG	B	1	1,4	-	0/6/23/26	0/1/1/1
4	NAG	B	2	4	-	1/6/23/26	0/1/1/1
4	BMA	B	3	4	-	1/2/19/22	0/1/1/1
4	FUC	B	4	4	-	-	0/1/1/1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	4	FUC	O5-C1	-3.13	1.38	1.43
4	B	1	NAG	O5-C1	2.78	1.48	1.43
4	B	4	FUC	C2-C3	2.20	1.55	1.52

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	B	3	BMA	C1-O5-C5	3.32	116.64	112.19
4	B	2	NAG	C1-O5-C5	2.33	115.30	112.19

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	B	2	NAG	C1-C2-N2-C7
4	B	3	BMA	C4-C5-C6-O6

There are no ring outliers.

3 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	3	BMA	2	0
4	B	1	NAG	1	0
4	B	2	NAG	2	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for oligosaccharide.

Oligosaccharide Chain B

Bond lengths

Bond angles

Torsions

Rings
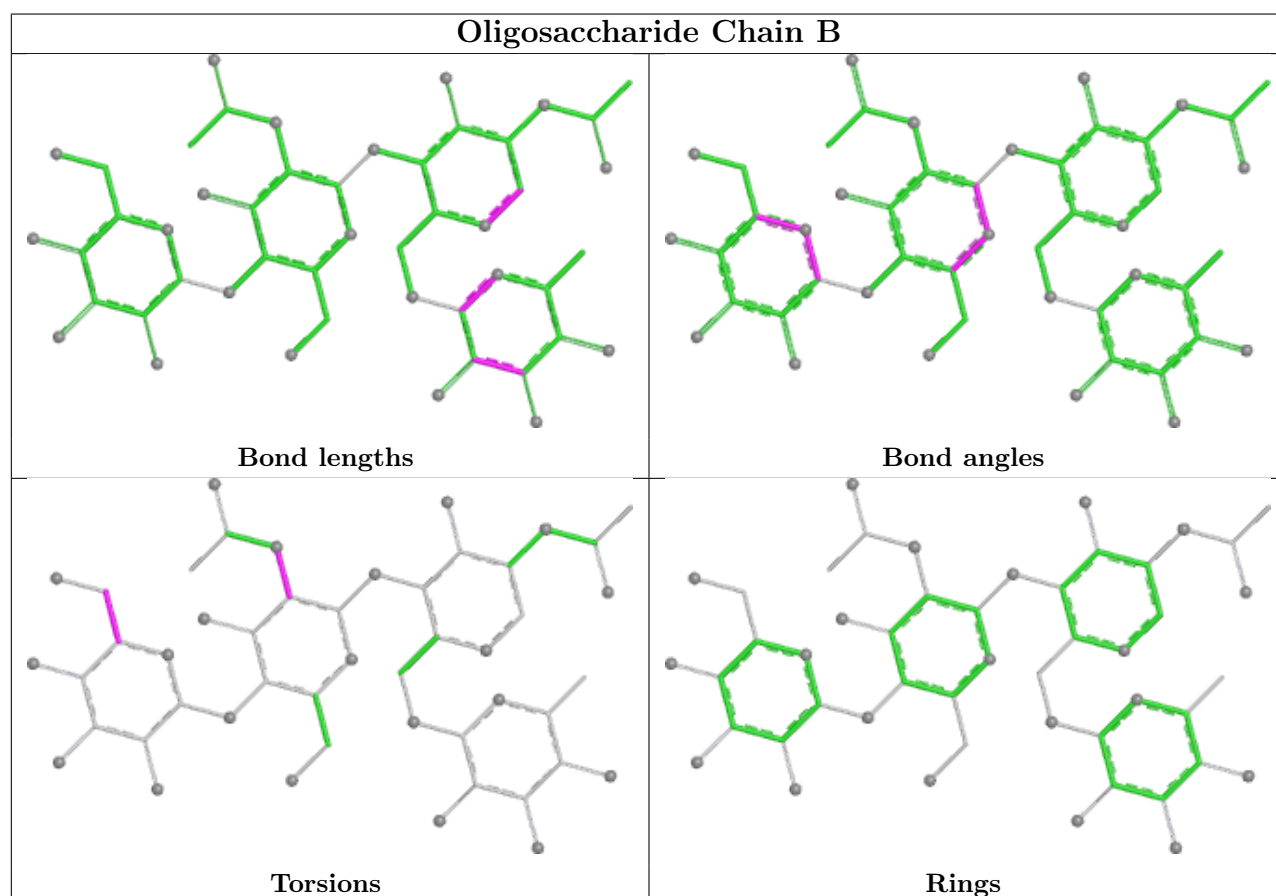
5.6 Ligand geometry ⓘ

There are no ligands in this entry.

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	108/125 (86%)	0.61	13 (12%)	10	10	12, 26, 41, 52	0
2	H	212/229 (92%)	0.45	14 (6%)	26	27	12, 24, 42, 48	0
3	L	213/215 (99%)	0.45	19 (8%)	17	18	11, 24, 45, 58	0
All	All	533/569 (93%)	0.48	46 (8%)	18	19	11, 24, 44, 58	0

All (46) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	58	VAL	5.7
3	L	213	GLY	5.1
1	A	14	HIS	4.1
3	L	153	ASN	3.7
3	L	154	ALA	3.5
2	H	210	THR	3.5
3	L	127	LYS	3.4
2	H	219	LYS	3.4
1	A	115	ILE	3.3
3	L	155	LEU	3.2
2	H	1	GLN	3.1
2	H	84	ASN	3.0
1	A	39	GLN	3.0
1	A	53	THR	2.9
3	L	26	SER	2.9
3	L	191	LYS	2.8
3	L	189	LYS	2.8
1	A	71	ASN	2.7
1	A	65	PHE	2.7
3	L	182	LEU	2.6
1	A	44	MET	2.6
2	H	131	PRO	2.6
1	A	116	ASP	2.5

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Mol	Chain	Res	Type	RSRZ
2	H	76	LYS	2.5
2	H	209	ASN	2.5
2	H	195	GLY	2.4
2	H	139	GLY	2.4
2	H	13	GLN	2.3
3	L	57	THR	2.3
3	L	128	SER	2.3
3	L	195	CYS	2.3
2	H	12	VAL	2.3
3	L	1	GLU	2.2
2	H	75	SER	2.2
3	L	185	ALA	2.2
3	L	129	GLY	2.2
2	H	155	VAL	2.2
1	A	83	ARG	2.2
2	H	177	SER	2.2
3	L	186	ASP	2.1
1	A	32	VAL	2.1
3	L	183	SER	2.1
1	A	114	VAL	2.1
3	L	29	VAL	2.0
1	A	70	PHE	2.0
3	L	151	VAL	2.0

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 ⓘ

SUGAR-RSR INFOmissingINFO

6.4 Ligands ⓘ

There are no ligands in this entry.

6.5 Other polymers ⓘ

There are no such residues in this entry.