W O R L D W I D E
wwPDB
P R O T E I N   D A T A   B A N K

wwPDB X-ray Structure Validation Summary Report (i)

Apr 30, 2024 – 11:41 pm BST

PDB ID	:	2XBO
Title	:	Equine Rhinitis A Virus in Complex with its Sialic Acid Receptor
Authors	:	Fry, E.E.; Tuthill, T.J.; Harlos, K.; Walter, T.S.; Rowlands, D.J.; Stuart, D.I.
Deposited on	:	2010-04-14
Resolution	:	4.00 Å(reported)

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

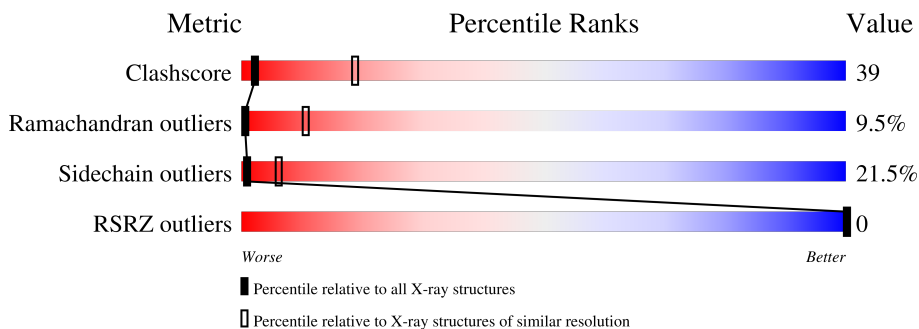|		
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36.2
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36.2

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 4.00 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
Clashscore		39
Ramachandran outliers		9.5%
Sidechain outliers		21.5%
RSRZ outliers		0

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))
Clashscore	141614	1148 (4.30-3.70)
Ramachandran outliers	138981	1108 (4.30-3.70)
Sidechain outliers	138945	1099 (4.30-3.70)
RSRZ outliers	127900	1028 (4.34-3.66)

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	1	248	29% 46% 19% 6%
2	2	230	29% 43% 12% • 13%
3	3	226	35% 50% 14% •
4	4	80	18% 6% • • 72%
5	A	3	33% 33% 33%

WORLDWIDE wwPDB PROTEIN DATA BANK

2　Entry composition ⓘ

There are 5 unique types of molecules in this entry. The entry contains 5415 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 P1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	1	247	Total	C	N	O	S	0	0	1
			1929	1240	330	351	8			

- Molecule 2 is a protein called P1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	2	200	Total	C	N	O	S	0	0	0
			1554	997	266	284	7			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
2	85	SER	GLY	conflict	UNP B9VV85

- Molecule 3 is a protein called P1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	3	226	Total	C	N	O	S	0	0	0
			1723	1112	279	326	6			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
3	59	LYS	ARG	conflict	UNP B9VV85
3	107	TYR	ARG	conflict	UNP B9VV85

- Molecule 4 is a protein called P1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	4	22	Total	C	N	O	S	0	0	1
			166	101	29	35	1			

- Molecule 5 is an oligosaccharide called N-acetyl-alpha-neuraminic acid-(2-3)-beta-D-galacto pyranose-(1-4)-alpha-D-glucopyranose.
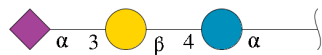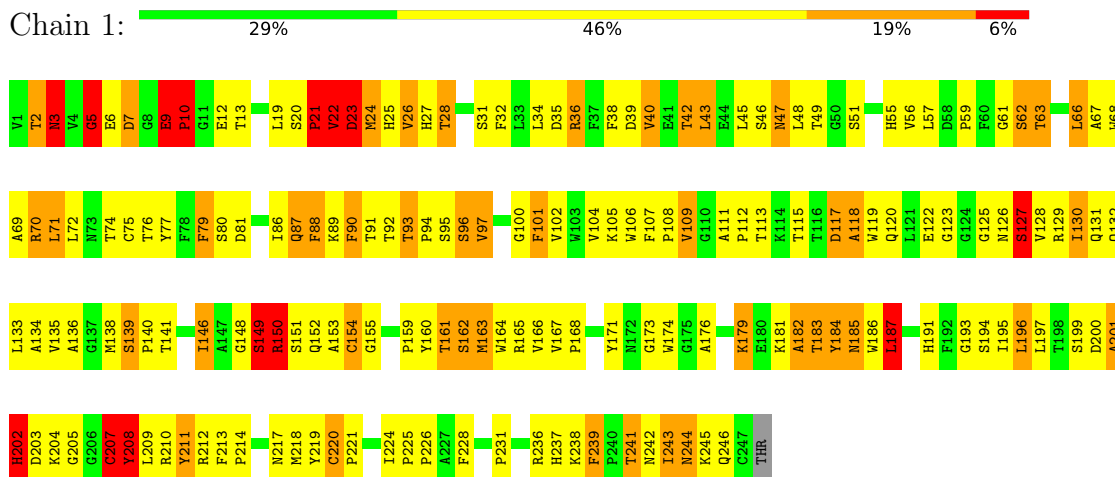

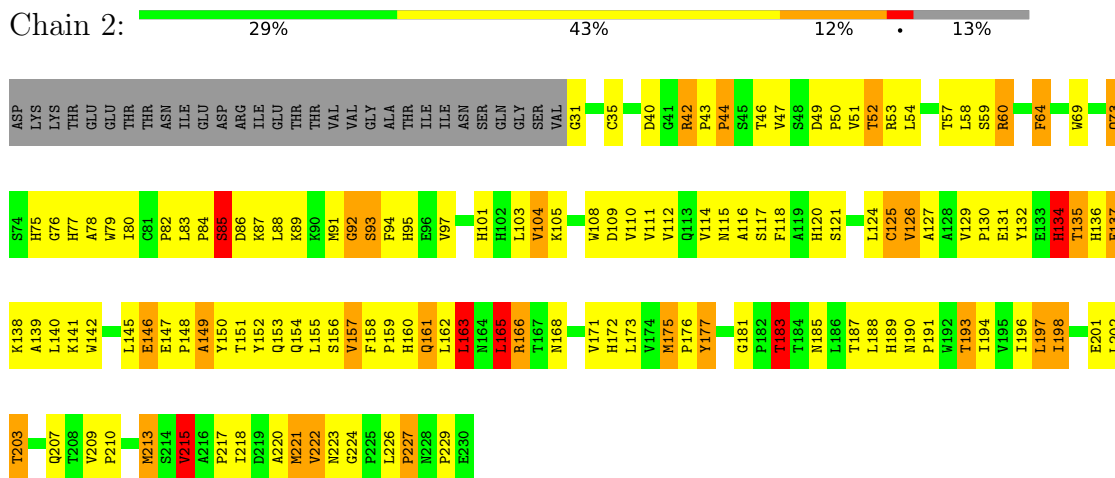| Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
5	A	3	Total 43	C 23	N 1	O 19	0	0	0

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.
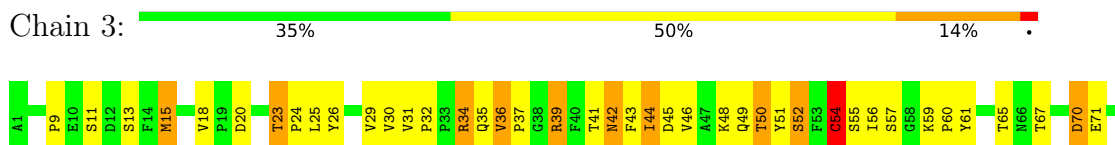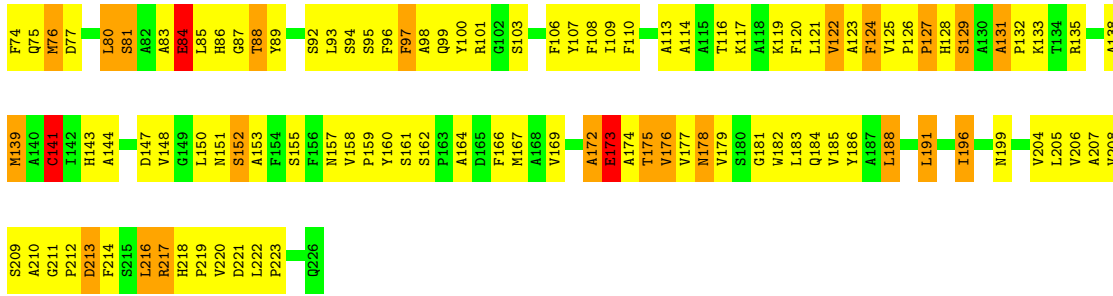
• Molecule 1: P1

• Molecule 2: P1

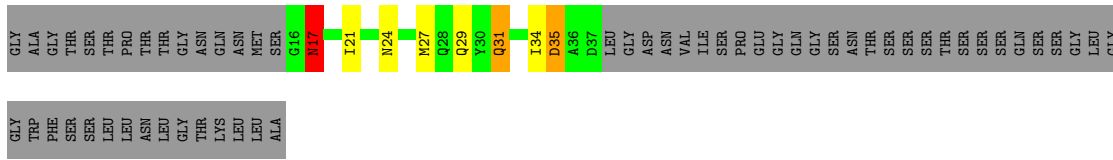• Molecule 3: P1

F74 Q75 M76 D77 L80 S81 A82 A83 E84 L85 H86 G87 T88 Y89 S92 L93 S94 S95 F96 F97 A98 Q99 Y100 R101 G102 S103 F106 Y107 F108 I109 F110 A113 A114 A115 T116 K117 A118 K119 F120 L121 V122 A123 F124 V125 P126 P127 H128 S129 A130 A131 P132 K133 T134 R135 A138

M139 A140 C141 I142 H143 A144 D147 V148 G149 L150 N151 S152 A153 F154 S155 F156 N157 V158 P159 Y160 S161 S162 P163 A164 D165 F166 M167 A168 V169 A172 E173 A174 T175 V176 V177 N178 V179 S180 G181 W182 L183 Q184 V185 Y186 A187 L188 L191 I196 N199 V204 L205 V206 A207 V208

S209 A210 G211 P212 D213 F214 S215 L216 R217 H218 P219 V220 D221 L222 P223 Q226

• Molecule 4: P1

Chain 4:

18%   6% • •   72%

GLY ALA GLY THR SER THR PRO THR THR GLY ASN GLN ASN MET SER G16 N17 I21 N24 M27 Q28 Q29 Y30 Q31 I34 D35 A36 D37 LEU GLY ASP ASN VAL ILE SER PRO GLU GLY GLN GLY SER ASN THR SER SER SER THR SER SER GLN SER SER GLY LEU GLY

GLY TRP PHE SER LEU LEU ASN LEU GLY THR LYS LEU LEU ALA

• Molecule 5: N-acetyl-alpha-neuraminic acid-(2-3)-beta-D-galactopyranose-(1-4)-alpha-D-glucop yranose

Chain A:

33%   33%   33%

GLC1 GAL2 SIA3
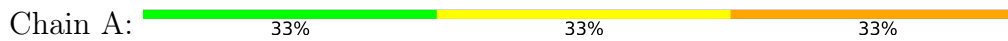
4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	344.80Å 531.40Å 488.30Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 4.00 29.66 – 4.00	Depositor EDS
% Data completeness (in resolution range)	7.8 (20.00-4.00) 7.8 (29.66-4.00)	Depositor EDS
R_{merge}	0.37	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$	-	Xtriage
Refinement program	X-PLOR 3.1	Depositor
R, R_{free}	0.247 , (Not available) 0.243 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å^2)	(Not available)	Xtriage
Anisotropy	(Not available)	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.58 , 75.5	EDS
L-test for twinning[1]	$< |L| >$ = (Not available), $< L^2 >$ = (Not available)	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.81	EDS
Total number of atoms	5415	wwPDB-VP
Average B, all atoms (Å^2)	13.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *(Not available)*

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[1]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: SIA, GAL, GLC

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	1	0.93	0/1993	1.23	13/2723 (0.5%)
2	2	1.00	1/1608 (0.1%)	1.19	9/2208 (0.4%)
3	3	1.02	3/1774 (0.2%)	1.12	3/2427 (0.1%)
4	4	1.16	0/168	1.13	1/226 (0.4%)
All	All	0.99	4/5543 (0.1%)	1.18	26/7584 (0.3%)

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	1	0	1
2	2	0	1
3	3	0	2
All	All	0	4

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	3	54	CYS	CB-SG	-6.11	1.71	1.82
3	3	141	CYS	CB-SG	-5.83	1.72	1.81
3	3	173	GLU	CG-CD	5.78	1.60	1.51
2	2	31	GLY	N-CA	5.11	1.53	1.46

The worst 5 of 26 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	1	5	GLY	N-CA-C	9.59	137.08	113.10
1	1	7	ASP	N-CA-C	-8.08	89.19	111.00

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	1	207	CYS	N-CA-C	7.52	131.30	111.00
1	1	203	ASP	N-CA-C	-6.75	92.79	111.00
3	3	208	VAL	CB-CA-C	-6.45	99.15	111.40

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	1	208	TYR	Sidechain
2	2	177	TYR	Sidechain
3	3	26	TYR	Sidechain
3	3	51	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	1	1929	0	1864	175	0
2	2	1554	0	1523	124	0
3	3	1723	0	1680	150	0
4	4	166	0	146	8	0
5	A	43	0	37	2	0
All	All	5415	0	5250	419	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 39.

The worst 5 of 419 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)
1:1:24:MET:SD	1:1:24:MET:CE	2.03	1.44
2:2:80:ILE:HG22	2:2:82:PRO:HD3	1.29	1.11
2:2:163:LEU:HD12	2:2:171:VAL:HG23	1.37	1.04
3:3:116:THR:HG23	3:3:191:LEU:HD11	1.42	1.00
2:2:213:MET:CE	2:2:215:VAL:HG22	1.96	0.95

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	1	245/248 (99%)	173 (71%)	41 (17%)	31 (13%)	0	5
2	2	198/230 (86%)	154 (78%)	27 (14%)	17 (9%)	1	12
3	3	224/226 (99%)	181 (81%)	28 (12%)	15 (7%)	1	17
4	4	20/80 (25%)	12 (60%)	6 (30%)	2 (10%)	0	9
All	All	687/784 (88%)	520 (76%)	102 (15%)	65 (10%)	0	10

5 of 65 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	1	5	GLY
1	1	9	GLU
1	1	10	PRO
1	1	21	PRO
1	1	22	VAL

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	1	208/210 (99%)	158 (76%)	50 (24%)	0	4
2	2	176/203 (87%)	141 (80%)	35 (20%)	1	8
3	3	190/190 (100%)	152 (80%)	38 (20%)	1	8

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
4	4	18/65 (28%)	14 (78%)	4 (22%)	1 6
All	All	592/668 (89%)	465 (78%)	127 (22%)	1 6

5 of 127 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	2	85	SER
3	3	161	SER
2	2	166	ARG
3	3	152	SER
3	3	191	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
3	3	184	GLN
4	4	24	ASN
2	2	95	HIS
2	2	101	HIS
2	2	134	HIS

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 ⓘ

3 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
5	GLC	A	1	5	12,12,12	0.70	0	17,17,17	0.68	0
5	GAL	A	2	5	11,11,12	0.65	0	15,15,17	0.73	0
5	SIA	A	3	5	20,20,21	1.11	2 (10%)	24,28,31	1.67	4 (16%)

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
5	GLC	A	1	5	-	2/2/22/22	0/1/1/1
5	GAL	A	2	5	-	2/2/19/22	0/1/1/1
5	SIA	A	3	5	-	2/18/34/38	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	A	3	SIA	C7-C6	-2.27	1.50	1.53
5	A	3	SIA	C4-C5	-2.26	1.51	1.53

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	A	3	SIA	C3-C4-C5	-5.14	105.25	111.46
5	A	3	SIA	C8-C7-C6	-3.18	107.00	113.03
5	A	3	SIA	C6-O6-C2	2.39	116.45	111.34
5	A	3	SIA	O1B-C1-C2	2.05	118.89	113.03

There are no chirality outliers.

5 of 6 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	2	GAL	O5-C5-C6-O6
5	A	1	GLC	O5-C5-C6-O6
5	A	2	GAL	C4-C5-C6-O6
5	A	1	GLC	C4-C5-C6-O6
5	A	3	SIA	O8-C8-C9-O9

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	2	GAL	2	0
5	A	3	SIA	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.
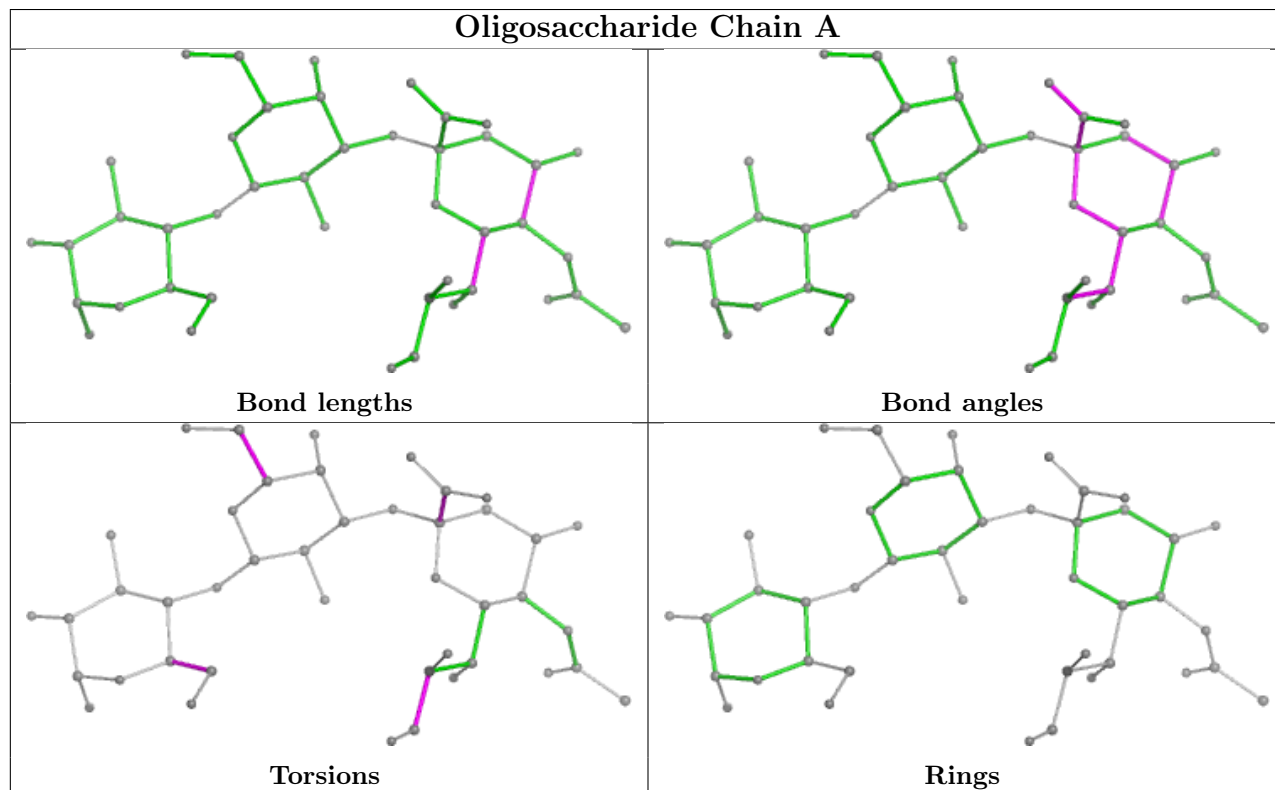
5.6 Ligand geometry ⓘ

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	1	247/248 (99%)	-1.12	0	100	100	2, 10, 44, 101	0
2	2	200/230 (86%)	-1.19	0	100	100	2, 6, 43, 88	0
3	3	226/226 (100%)	-1.25	0	100	100	2, 4, 26, 61	0
4	4	22/80 (27%)	-0.75	0	100	100	15, 37, 55, 71	0
All	All	695/784 (88%)	-1.17	0	100	100	2, 6, 44, 101	0

There are no RSRZ outliers to report.

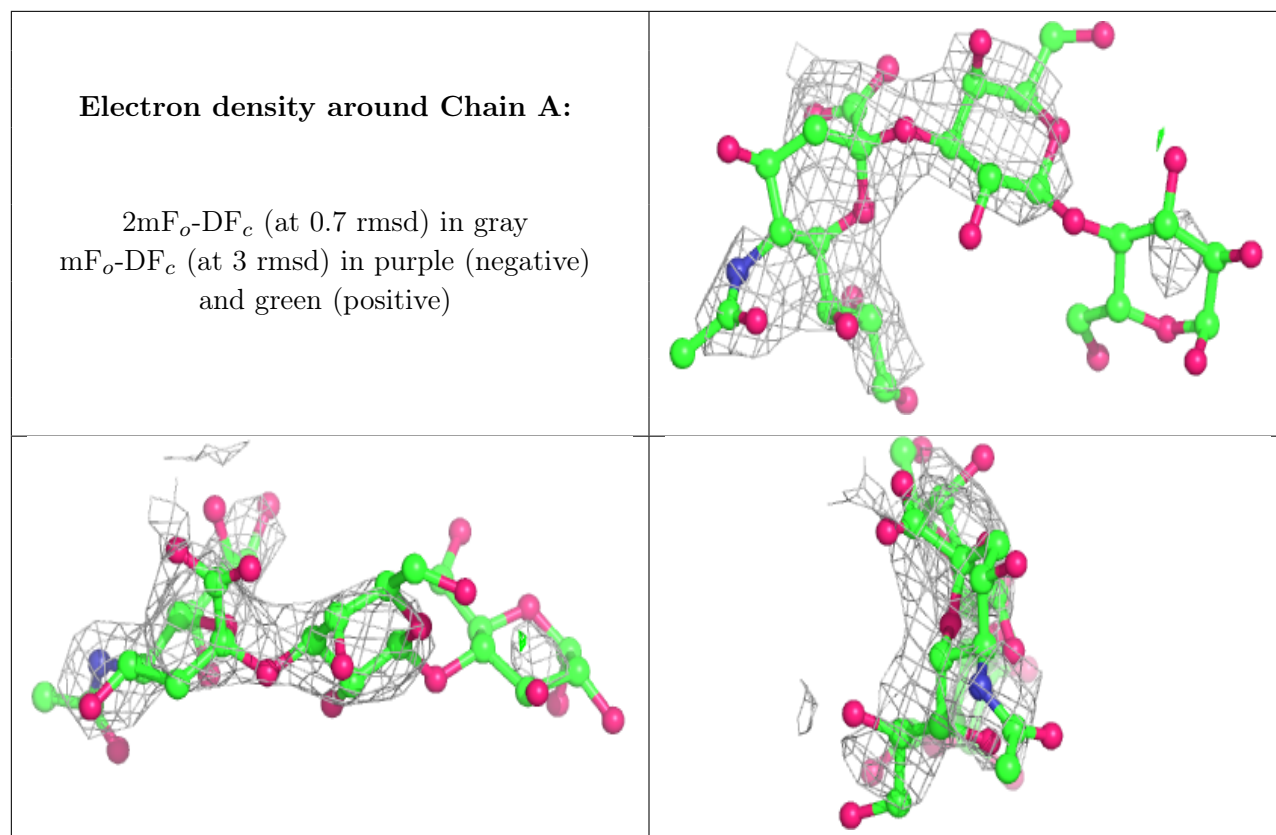## 6.2   Non-standard residues in protein, DNA, RNA chains ⓘ

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. 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(Å²)	Q<0.9
5	GLC	A	1	12/12	0.86	0.94	62,73,74,75	12
5	GAL	A	2	11/12	0.94	0.54	35,47,53,55	11
5	SIA	A	3	20/21	0.96	0.32	3,18,26,27	20

The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around Chain A:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

6.4 Ligands ⓘ

There are no ligands in this entry.

6.5 Other polymers ⓘ

There are no such residues in this entry.