Full wwPDB X-ray Structure Validation Report (i)

Aug 14, 2023 – 09:12 PM EDT

PDB ID	:	1RWH
Title	:	Crystal structure of Arthrobacter aurescens chondroitin AC lyase in complex with chondroitin tetrasaccharide
Authors	:	Lunin, V.V.; Li, Y.; Miyazono, H.; Kyogashima, M.; Bell, A.W.; Cygler, M.
Deposited on	:	2003-12-16
Resolution	:	1.25 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:

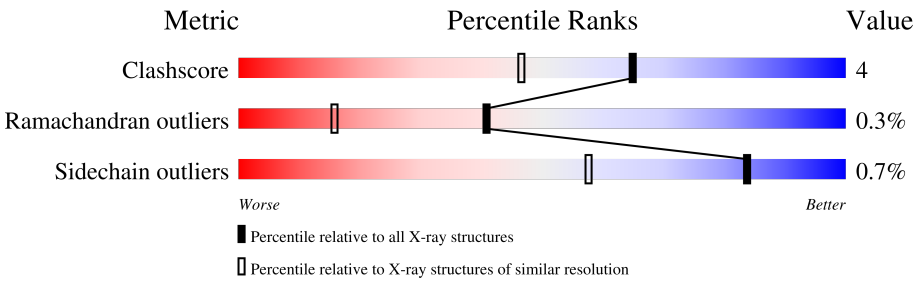
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35

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 1.25 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))
Clashscore	141614	1060 (1.28-1.24)
Ramachandran outliers	138981	1029 (1.28-1.24)
Sidechain outliers	138945	1028 (1.28-1.24)

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%

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	757	92% 7% •
2	B	4	25% 75%

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
2	GCT	B	2	-	-	X	-
4	PO4	A	850	-	-	X	-

2 Entry composition (i)

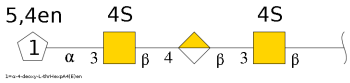
There are 6 unique types of molecules in this entry. The entry contains 6837 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 chondroitin AC lyase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	754	5646	3544	989	1095	18	0	15	0

- Molecule 2 is an oligosaccharide called 2,6-anhydro-3-deoxy-L-threo-hex-2-enonic acid-(1-3)-2-acetamido-2-deoxy-4-O-sulfo-beta-D-galactopyranose-(1-4)-2,6-anhydro-3-deoxy-L-xylo-hexonic acid-(1-3)-2-acetamido-2-deoxy-4-O-sulfo-beta-D-galactopyranose.

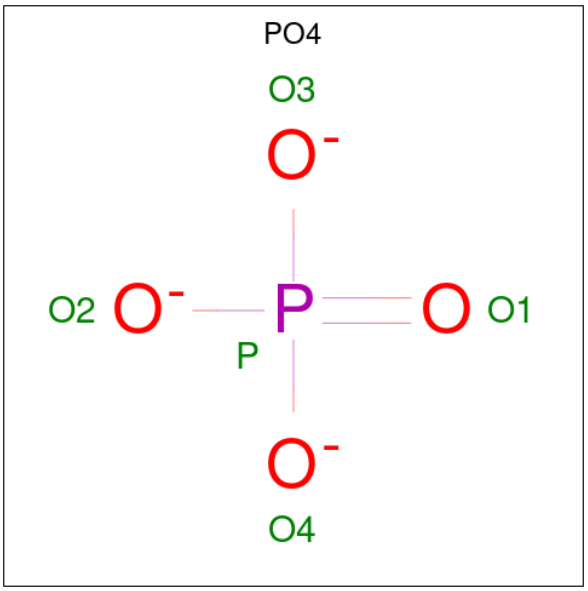


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	4	60	28	2	28	2	0	0	0

- Molecule 3 is SODIUM ION (three-letter code: NA) (formula: Na).

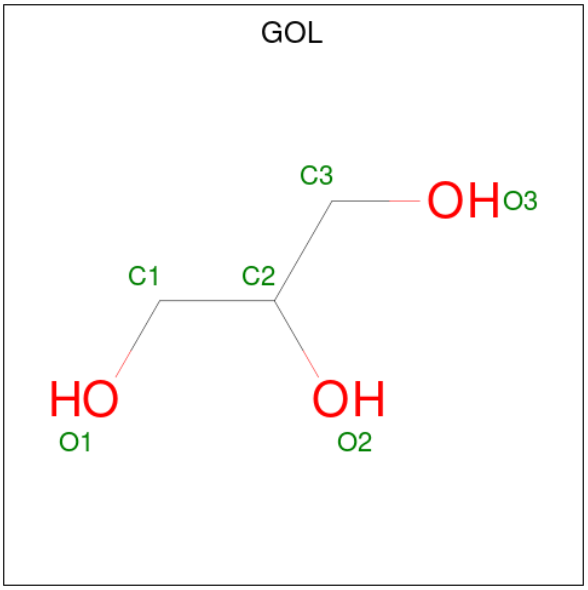
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Na		
3	A	1	1	1	0	0

- Molecule 4 is PHOSPHATE ION (three-letter code: PO4) (formula: O_4P).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total O P 5 4 1	0	0

- Molecule 5 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).



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

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
6	A	1107	1107	1107	0	0

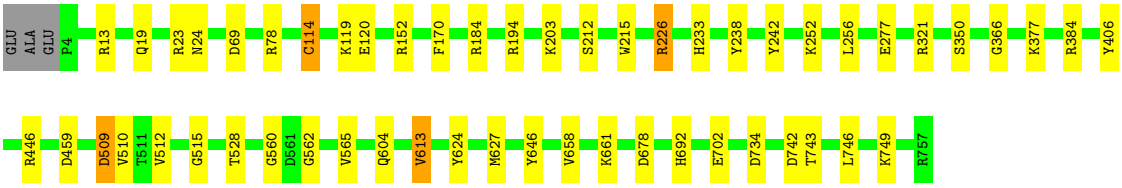
3 Residue-property plots (i)

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. 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. 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.

Note EDS was not executed.

• Molecule 1: chondroitin AC lyase

Chain A:



• Molecule 2: 2,6-anhydro-3-deoxy-L-threo-hex-2-enonic acid-(1-3)-2-acetamido-2-deoxy-4-O-sulfo-beta-D-galactopyranose-(1-4)-2,6-anhydro-3-deoxy-L-xylo-hexonic acid-(1-3)-2-acetamido-2-deoxy-4-O-sulfo-beta-D-galactopyranose

Chain B:

4 Data and refinement statistics (i)

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	57.62Å 86.31Å 80.51Å 90.00° 106.95° 90.00°	Depositor
Resolution (Å)	25.24 – 1.25	Depositor
% Data completeness (in resolution range)	100.0 (25.24-1.25)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
Refinement program	REFMAC 5.1.08	Depositor
R, R_{free}	0.113 , 0.142	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	6837	wwPDB-VP
Average B, all atoms (Å^2)	16.0	wwPDB-VP

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: ASG, GAD, NA, PO4, GCT, 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	1.00	12/5844 (0.2%)	1.00	15/7965 (0.2%)

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	509[A]	ASP	CB-CG	-7.87	1.35	1.51
1	A	509[B]	ASP	CB-CG	-7.87	1.35	1.51
1	A	661	LYS	CE-NZ	7.14	1.67	1.49
1	A	24	ASN	CG-OD1	6.79	1.38	1.24
1	A	24	ASN	CB-CG	6.51	1.66	1.51
1	A	565	VAL	CB-CG1	-6.43	1.39	1.52
1	A	613[A]	VAL	CB-CG2	-6.32	1.39	1.52
1	A	613[B]	VAL	CB-CG2	-6.32	1.39	1.52
1	A	604	GLN	CG-CD	5.79	1.64	1.51
1	A	277[A]	GLU	CD-OE2	5.48	1.31	1.25
1	A	277[B]	GLU	CD-OE2	5.48	1.31	1.25
1	A	114	CYS	CB-SG	-5.01	1.73	1.81

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	152	ARG	NE-CZ-NH1	13.55	127.07	120.30
1	A	459	ASP	CB-CG-OD2	9.53	126.88	118.30
1	A	152	ARG	NE-CZ-NH2	-7.25	116.68	120.30
1	A	184	ARG	NE-CZ-NH2	-7.24	116.68	120.30
1	A	78	ARG	NE-CZ-NH1	-6.50	117.05	120.30
1	A	69	ASP	CB-CG-OD2	5.88	123.59	118.30
1	A	226	ARG	NE-CZ-NH1	5.87	123.23	120.30
1	A	13	ARG	NE-CZ-NH2	-5.78	117.41	120.30
1	A	384	ARG	NE-CZ-NH2	-5.75	117.43	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	321	ARG	NE-CZ-NH2	-5.60	117.50	120.30
1	A	23	ARG	NE-CZ-NH2	-5.59	117.50	120.30
1	A	742	ASP	CB-CG-OD1	5.49	123.24	118.30
1	A	678	ASP	CB-CG-OD2	5.37	123.14	118.30
1	A	734	ASP	CB-CG-OD2	5.26	123.03	118.30
1	A	446	ARG	NE-CZ-NH2	-5.12	117.74	120.30

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	5646	0	5522	37	0
2	B	60	0	28	14	0
3	A	1	0	0	0	0
4	A	5	0	0	3	0
5	A	18	0	24	0	0
6	A	1107	0	0	16	2
All	All	6837	0	5574	46	2

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 4.

All (46) 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:510[A]:VAL:HG11	1:A:627[A]:MET:CE	1.45	1.41
2:B:2:GCT:HC42	2:B:3:ASG:O1	1.17	1.35
2:B:2:GCT:HC42	2:B:3:ASG:C1	1.73	1.18
1:A:114:CYS:HB3	6:A:1677:HOH:O	1.47	1.15
1:A:510[A]:VAL:CG1	1:A:627[A]:MET:CE	2.23	1.14
1:A:510[A]:VAL:CG1	1:A:627[A]:MET:HE3	1.79	1.11
1:A:114:CYS:SG	6:A:1677:HOH:O	2.10	1.08
1:A:510[A]:VAL:HG11	1:A:627[A]:MET:HE3	1.05	1.03

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:114:CYS:CB	6:A:1677:HOH:O	2.02	0.91
1:A:366:GLY:HA2	6:A:2101:HOH:O	1.73	0.89
1:A:510[A]:VAL:CG1	1:A:627[A]:MET:HE2	2.05	0.85
1:A:203:LYS:NZ	6:A:1662:HOH:O	2.10	0.82
1:A:242:TYR:HH	2:B:2:GCT:HC5	1.43	0.82
1:A:242:TYR:OH	2:B:2:GCT:HC5	1.85	0.75
1:A:510[A]:VAL:HG11	1:A:627[A]:MET:HE1	1.68	0.71
1:A:510[A]:VAL:HG13	1:A:627[A]:MET:HE2	1.74	0.69
4:A:850:PO4:O4	2:B:2:GCT:HC2	1.95	0.67
1:A:509[B]:ASP:OD1	6:A:1398:HOH:O	2.12	0.66
4:A:850:PO4:O4	2:B:2:GCT:C2	2.45	0.63
1:A:692:HIS:HD2	6:A:1544:HOH:O	1.85	0.58
2:B:2:GCT:C5	2:B:3:ASG:O1	2.50	0.57
1:A:226:ARG:NH2	6:A:1345:HOH:O	2.22	0.57
1:A:233:HIS:CD2	2:B:1:ASG:OSA	2.58	0.57
1:A:562:GLY:O	6:A:2034:HOH:O	2.18	0.55
1:A:510[B]:VAL:HG21	1:A:646:TYR:CE2	2.43	0.53
2:B:2:GCT:HC42	2:B:3:ASG:H1	1.83	0.52
1:A:512:VAL:HG11	1:A:658[A]:VAL:HG11	1.92	0.51
1:A:743:THR:HA	1:A:746:LEU:HD12	1.93	0.49
2:B:2:GCT:HC5	2:B:3:ASG:O1	2.12	0.48
1:A:515:GLY:HA3	1:A:624:TYR:CE2	2.48	0.48
6:A:2051:HOH:O	2:B:1:ASG:H6A	2.12	0.48
1:A:119:LYS:HE3	1:A:120:GLU:O	2.15	0.47
1:A:528:THR:HB	1:A:613[A]:VAL:HG22	1.98	0.46
1:A:226:ARG:NE	6:A:1345:HOH:O	2.40	0.46
1:A:377:LYS:HD2	6:A:1682:HOH:O	2.15	0.46
1:A:692:HIS:CD2	6:A:1544:HOH:O	2.66	0.45
1:A:212:SER:HA	1:A:215:TRP:CZ2	2.52	0.44
1:A:749:LYS:HE2	6:A:1308:HOH:O	2.17	0.44
1:A:350:SER:C	6:A:1560:HOH:O	2.57	0.43
1:A:377:LYS:HB3	6:A:1682:HOH:O	2.18	0.43
1:A:19[B]:GLN:HE22	1:A:256:LEU:N	2.17	0.42
1:A:528:THR:HB	1:A:613[A]:VAL:CG2	2.50	0.42
1:A:19[A]:GLN:HE22	1:A:252:LYS:HB3	1.85	0.42
4:A:850:PO4:O4	2:B:2:GCT:C1	2.67	0.41
1:A:242:TYR:HH	2:B:2:GCT:C5	2.23	0.41
1:A:233:HIS:NE2	2:B:1:ASG:H4	2.36	0.41

All (2) 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)
6:A:1486:HOH:O	6:A:2077:HOH:O[1_556]	1.79	0.41
6:A:1955:HOH:O	6:A:2074:HOH:O[1_655]	2.18	0.02

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	767/757 (101%)	752 (98%)	13 (2%)	2 (0%)	41 16

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	560	GLY
1	A	170	PHE

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	583/570 (102%)	579 (99%)	4 (1%)	84 57

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	194	ARG
1	A	238	TYR
1	A	406	TYR

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Mol	Chain	Res	Type
1	A	702	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	189	GLN
1	A	216	GLN

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)

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	$\#\|Z\| > 2$
2	ASG	B	1	2	19,19,19	1.14	1 (5%)	23,28,28	1.61	7 (30%)
2	GCT	B	2	2	11,11,11	1.64	2 (18%)	12,15,15	2.85	4 (33%)
2	ASG	B	3	2	19,19,19	1.06	0	23,28,28	1.44	3 (13%)
2	GAD	B	4	2	10,11,11	1.60	3 (30%)	13,15,15	2.30	4 (30%)

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	ASG	B	1	2	-	5/11/31/31	0/1/1/1
2	GCT	B	2	2	-	0/4/17/17	0/1/1/1
2	ASG	B	3	2	-	0/11/31/31	0/1/1/1
2	GAD	B	4	2	-	2/4/17/17	0/1/1/1

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	2	GCT	O3-C3	-4.07	1.34	1.43
2	B	1	ASG	OSC-S	3.57	1.60	1.45
2	B	4	GAD	O5-C1	-2.87	1.40	1.45
2	B	4	GAD	C3-C4	2.79	1.54	1.50
2	B	2	GCT	C5-C6	2.25	1.54	1.52
2	B	4	GAD	O5-C5	2.09	1.40	1.37

All (18) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	2	GCT	C1-O5-C5	7.21	124.94	113.92
2	B	4	GAD	O5-C5-C4	-6.69	119.16	124.81
2	B	3	ASG	C1-C2-N2	3.97	115.33	110.73
2	B	2	GCT	O2-C2-C3	-3.48	102.51	110.22
2	B	2	GCT	O5-C1-C2	3.30	115.87	110.77
2	B	1	ASG	O3-C3-C2	-3.16	103.28	109.66
2	B	2	GCT	C4-C3-C2	-3.10	106.43	110.27
2	B	1	ASG	O5-C5-C6	3.07	114.08	106.44
2	B	1	ASG	C1-C2-N2	2.85	114.03	110.73
2	B	1	ASG	C1-C2-C3	2.65	114.16	110.54
2	B	4	GAD	C2-C3-C4	-2.58	108.79	112.32
2	B	4	GAD	C3-C4-C5	2.48	125.79	121.60
2	B	3	ASG	OSA-S-OSC	2.40	116.84	108.49
2	B	1	ASG	C3-C4-C5	-2.32	105.61	110.93
2	B	4	GAD	O5-C5-C6	2.31	114.99	111.52
2	B	3	ASG	C3-C2-N2	-2.27	106.33	110.62
2	B	1	ASG	C8-C7-N2	-2.14	112.47	116.10
2	B	1	ASG	O5-C1-C2	-2.13	107.37	109.52

There are no chirality outliers.

All (7) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	1	ASG	C5-C4-O4-S

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Mol	Chain	Res	Type	Atoms
2	B	1	ASG	C4-O4-S-OSA
2	B	1	ASG	C4-O4-S-OSB
2	B	1	ASG	C4-O4-S-OSC
2	B	4	GAD	C4-C5-C6-O6A
2	B	1	ASG	C3-C4-O4-S
2	B	4	GAD	O5-C5-C6-O6A

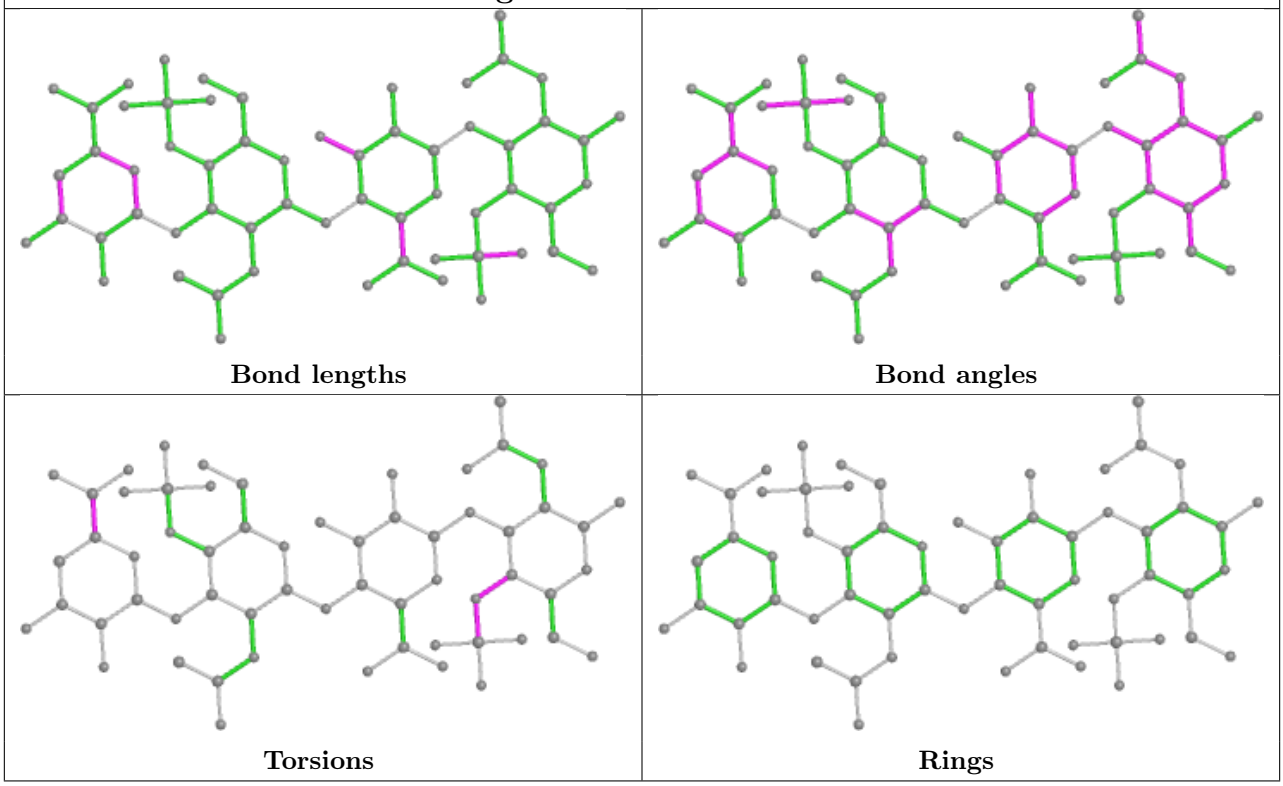
There are no ring outliers.

3 monomers are involved in 14 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	3	ASG	5	0
2	B	2	GCT	11	0
2	B	1	ASG	3	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



5.6 Ligand geometry (i)

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	$\#\|Z\| > 2$
5	GOL	A	803	-	5,5,5	0.48	0	5,5,5	0.80	0
5	GOL	A	802	-	5,5,5	0.32	0	5,5,5	0.70	0
5	GOL	A	801	-	5,5,5	0.67	0	5,5,5	0.49	0
4	PO4	A	850	-	4,4,4	1.78	1 (25%)	6,6,6	1.53	2 (33%)

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	GOL	A	803	-	-	0/4/4/4	-
5	GOL	A	802	-	-	0/4/4/4	-
5	GOL	A	801	-	-	0/4/4/4	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	850	PO4	P-O2	-3.08	1.45	1.54

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	850	PO4	O3-P-O2	2.48	115.92	107.97
4	A	850	PO4	O4-P-O1	-2.41	102.09	110.89

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	850	PO4	3	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)

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates (i)

EDS was not executed - this section is therefore empty.

6.4 Ligands (i)

EDS was not executed - this section is therefore empty.

6.5 Other polymers (i)

EDS was not executed - this section is therefore empty.