



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 17, 2026 – 04:22 PM UTC

PDB ID : 1K9D / pdb_00001k9d
Title : The 1.7 Å crystal structure of alpha-D-glucuronidase, a family-67 glycoside hydrolase from *Bacillus stearothermophilus* T-1
Authors : Golan, G.; Shallom, D.; Teplitsky, A.; Zaide, G.; Shulami, S.; Baasov, T.; Stojanoff, V.; Thompson, A.; Shoham, Y.; Shoham, G.
Deposited on : 2001-10-29
Resolution : 1.70 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 ⓘ 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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

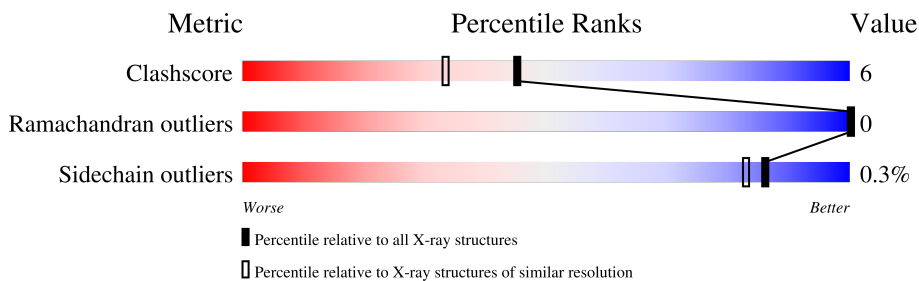
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.70 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	190562	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	679	

2 Entry composition [i](#)

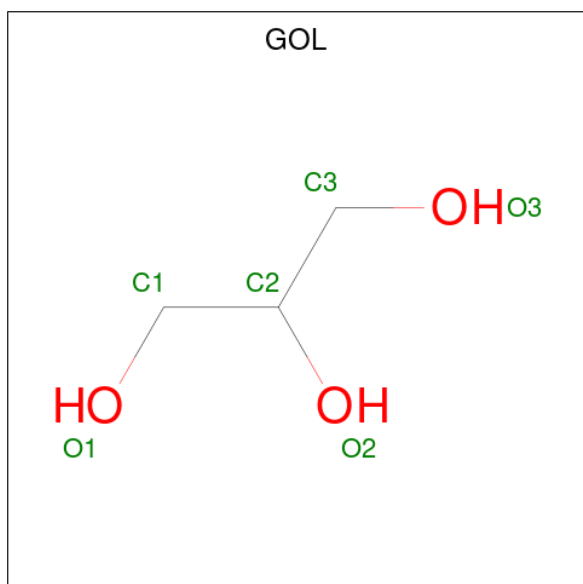
There are 3 unique types of molecules in this entry. The entry contains 6387 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 alpha-D-glucuronidase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	670	5659	3608	968	1062	21	0	26	0

- Molecule 2 is GLYCEROL (CCD ID: GOL) (formula: C₃H₈O₃).



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

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

- Molecule 3 is water.

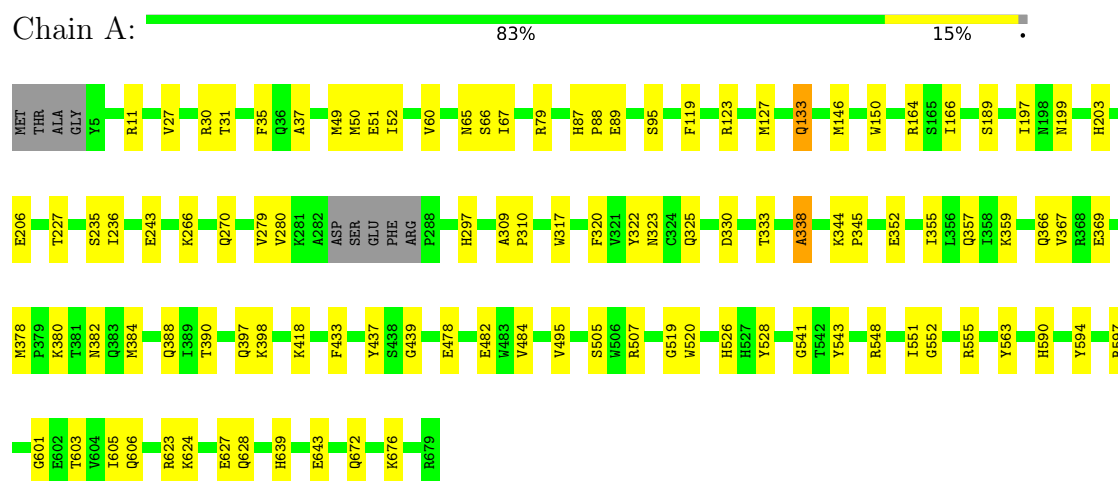
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	650	Total	O	0	0
			650	650		

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. 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: alpha-D-glucuronidase



4 Data and refinement statistics

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

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α , β , γ	73.57Å 73.57Å 329.96Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	35.90 – 1.70	Depositor
% Data completeness (in resolution range)	93.5 (35.90-1.70)	Depositor
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS 1.0	Depositor
R, R_{free}	0.176 , 0.203	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	6387	wwPDB-VP
Average B, all atoms (Å ²)	20.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: 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	0.36	1/5814 (0.0%)	0.88	19/7889 (0.2%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	133	GLN	C-N	-10.21	1.19	1.33

All (19) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	398	LYS	N-CA-C	-8.72	101.08	112.68
1	A	505	SER	N-CA-C	7.70	120.35	111.11
1	A	676	LYS	N-CA-C	7.54	120.01	109.15
1	A	603	THR	N-CA-C	-7.44	100.50	110.55
1	A	146	MET	N-CA-C	6.88	120.80	110.14
1	A	279	VAL	N-CA-C	-6.83	98.61	108.17
1	A	338	ALA	N-CA-C	6.53	118.95	111.11
1	A	280	VAL	N-CA-C	6.49	117.46	108.12
1	A	67	ILE	N-CA-C	-5.67	99.48	107.75
1	A	235	SER	N-CA-C	-5.52	101.48	110.20
1	A	65	ASN	N-CA-C	-5.49	101.03	109.76
1	A	197	ILE	N-CA-C	5.37	120.38	113.07
1	A	520	TRP	N-CA-C	5.33	117.08	108.08
1	A	166	ILE	N-CA-C	-5.20	107.69	112.83
1	A	79	ARG	CA-C-N	5.08	124.53	119.24
1	A	79	ARG	C-N-CA	5.08	124.53	119.24
1	A	243	GLU	N-CA-C	5.05	116.79	111.28
1	A	378	MET	CA-C-N	5.03	125.30	119.47
1	A	378	MET	C-N-CA	5.03	125.30	119.47

There are no chirality outliers.

There are no planarity outliers.

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	5659	0	5379	65	0
2	A	78	0	104	4	0
3	A	650	0	0	15	0
All	All	6387	0	5483	66	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 6.

All (66) 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:367[A]:VAL:HG21	3:A:987:HOH:O	1.73	0.87
1:A:87:HIS:HD2	1:A:89:GLU:H	1.26	0.84
1:A:367[A]:VAL:HG22	3:A:1047:HOH:O	1.78	0.82
1:A:30[B]:ARG:CA	1:A:31:THR:N	2.43	0.81
1:A:320:PHE:HB2	3:A:1165:HOH:O	1.89	0.70
1:A:357:GLN:OE1	1:A:384[A]:MET:HE3	1.93	0.69
1:A:359:LYS:HG3	3:A:1165:HOH:O	1.93	0.68
1:A:297:HIS:CD2	1:A:317:TRP:HE1	2.12	0.68
1:A:526:HIS:HD2	1:A:528:TYR:H	1.45	0.64
1:A:526:HIS:CD2	1:A:528:TYR:H	2.17	0.62
1:A:322:TYR:HB3	3:A:1319:HOH:O	1.99	0.62
1:A:344:LYS:HB3	1:A:345:PRO:HD3	1.82	0.62
1:A:87:HIS:CD2	1:A:89:GLU:H	2.13	0.61
1:A:478:GLU:O	1:A:482:GLU:HG3	2.02	0.59
1:A:597[A]:ARG:HD2	1:A:601:GLY:O	2.03	0.58
1:A:150:TRP:HA	1:A:199:ASN:HA	1.87	0.56
1:A:555:ARG:HB3	1:A:563:TYR:HB3	1.88	0.56
1:A:355[B]:ILE:HD11	1:A:437:TYR:HB3	1.87	0.56
1:A:338:ALA:HB3	3:A:1319:HOH:O	2.06	0.55
1:A:50[A]:MET:HB2	1:A:52:ILE:HG12	1.87	0.55

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:380:LYS:HE2	3:A:1402:HOH:O	2.06	0.55
1:A:11:ARG:HH12	2:A:708:GOL:H12	1.72	0.54
1:A:541:GLY:HA2	1:A:543:TYR:CE2	2.42	0.54
1:A:266:LYS:O	1:A:270:GLN:HG3	2.08	0.54
1:A:87:HIS:HB2	3:A:1177:HOH:O	2.09	0.53
1:A:37:ALA:HB2	1:A:227[A]:THR:HG22	1.91	0.51
1:A:507:ARG:HD2	2:A:713:GOL:O2	2.11	0.51
1:A:388:GLN:HG2	1:A:390:THR:O	2.11	0.50
1:A:355[A]:ILE:HD12	1:A:355[A]:ILE:N	2.27	0.50
1:A:323:ASN:C	1:A:325:GLN:H	2.20	0.49
1:A:164:ARG:HD3	3:A:1023:HOH:O	2.12	0.49
1:A:51[B]:GLU:O	1:A:51[B]:GLU:HG3	2.13	0.49
1:A:309:ALA:HB3	1:A:310:PRO:HD3	1.94	0.49
1:A:30[B]:ARG:HB2	1:A:35:PHE:CG	2.48	0.48
1:A:519:GLY:HA2	3:A:1047:HOH:O	2.13	0.48
1:A:382:ASN:HB3	1:A:437:TYR:O	2.14	0.47
1:A:594:TYR:HB3	1:A:605:ILE:HB	1.96	0.47
1:A:236:ILE:HD12	1:A:236:ILE:C	2.41	0.46
1:A:320:PHE:HB3	3:A:1154:HOH:O	2.16	0.46
1:A:119:PHE:CG	1:A:189:SER:HA	2.52	0.45
1:A:606:GLN:HG2	1:A:672:GLN:HE21	1.82	0.45
1:A:95[A]:SER:OG	1:A:133:GLN:HA	2.16	0.44
1:A:548:ARG:HD3	3:A:1264:HOH:O	2.16	0.44
1:A:366:GLN:HB2	1:A:369:GLU:HG3	2.00	0.44
1:A:123:ARG:O	1:A:127[B]:MET:HG2	2.18	0.44
1:A:484:VAL:HG11	1:A:495:VAL:HA	1.99	0.43
1:A:352:GLU:H	1:A:352:GLU:CD	2.27	0.43
1:A:27:VAL:HG21	1:A:60[B]:VAL:HG12	2.00	0.43
1:A:384[A]:MET:HG3	1:A:439:GLY:C	2.44	0.42
1:A:330:ASP:OD2	1:A:333:THR:HG23	2.19	0.42
1:A:355[B]:ILE:HD11	1:A:437:TYR:CB	2.48	0.42
1:A:623:ARG:O	1:A:627:GLU:HG3	2.19	0.42
1:A:590:HIS:ND1	2:A:706:GOL:H2	2.34	0.42
1:A:30[A]:ARG:HG2	1:A:30[A]:ARG:HH11	1.84	0.42
2:A:713:GOL:H31	3:A:1274:HOH:O	2.20	0.42
1:A:60[B]:VAL:HG13	3:A:995:HOH:O	2.19	0.42
1:A:639:HIS:O	1:A:643[B]:GLU:HG3	2.20	0.41
1:A:639:HIS:O	1:A:643[A]:GLU:HG3	2.20	0.41
1:A:203:HIS:HB2	1:A:206:GLU:OE1	2.21	0.41
1:A:507:ARG:HG3	3:A:1224:HOH:O	2.20	0.41
1:A:418:LYS:HE3	1:A:433:PHE:CE1	2.56	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:624:LYS:O	1:A:628:GLN:HG3	2.21	0.41
1:A:49:MET:HB3	1:A:50[A]:MET:HE2	2.01	0.41
1:A:87:HIS:HA	1:A:88:PRO:HD3	1.94	0.40
1:A:297:HIS:HD2	1:A:317:TRP:HE1	1.67	0.40
1:A:551:ILE:HG12	1:A:552:GLY:N	2.36	0.40

There are no symmetry-related clashes.

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	692/679 (102%)	673 (97%)	19 (3%)	0	100	100

There are no Ramachandran outliers to report.

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	598/586 (102%)	595 (100%)	3 (0%)	81	76

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	66[A]	SER

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Mol	Chain	Res	Type
1	A	66[B]	SER
1	A	397	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (12) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	17	GLN
1	A	87	HIS
1	A	142	ASN
1	A	148	ASN
1	A	297	HIS
1	A	349	GLN
1	A	357	GLN
1	A	360	ASN
1	A	406	GLN
1	A	526	HIS
1	A	531	ASN
1	A	672	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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

13 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	$\# Z > 2$
2	GOL	A	701	-	5,5,5	0.73	0	5,5,5	0.45	0
2	GOL	A	703	-	5,5,5	0.86	0	5,5,5	0.42	0
2	GOL	A	704	-	5,5,5	0.82	0	5,5,5	0.45	0
2	GOL	A	708	-	5,5,5	0.78	0	5,5,5	0.45	0
2	GOL	A	709	-	5,5,5	0.79	0	5,5,5	0.43	0
2	GOL	A	713	-	5,5,5	0.86	0	5,5,5	0.44	0
2	GOL	A	712	-	5,5,5	0.79	0	5,5,5	0.46	0
2	GOL	A	710	-	5,5,5	0.81	0	5,5,5	0.43	0
2	GOL	A	702	-	5,5,5	0.80	0	5,5,5	0.43	0
2	GOL	A	711	-	5,5,5	0.81	0	5,5,5	0.49	0
2	GOL	A	706	-	5,5,5	0.71	0	5,5,5	0.43	0
2	GOL	A	707	-	5,5,5	0.75	0	5,5,5	0.43	0
2	GOL	A	705	-	5,5,5	0.72	0	5,5,5	0.44	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
2	GOL	A	701	-	-	0/4/4/4	-
2	GOL	A	703	-	-	2/4/4/4	-
2	GOL	A	704	-	-	0/4/4/4	-
2	GOL	A	708	-	-	0/4/4/4	-
2	GOL	A	709	-	-	0/4/4/4	-
2	GOL	A	713	-	-	2/4/4/4	-
2	GOL	A	712	-	-	2/4/4/4	-
2	GOL	A	710	-	-	2/4/4/4	-
2	GOL	A	702	-	-	2/4/4/4	-
2	GOL	A	711	-	-	4/4/4/4	-
2	GOL	A	706	-	-	4/4/4/4	-
2	GOL	A	707	-	-	4/4/4/4	-
2	GOL	A	705	-	-	2/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (24) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	703	GOL	C1-C2-C3-O3
2	A	705	GOL	O1-C1-C2-O2
2	A	705	GOL	O1-C1-C2-C3
2	A	706	GOL	C1-C2-C3-O3
2	A	706	GOL	O2-C2-C3-O3
2	A	707	GOL	O1-C1-C2-C3
2	A	707	GOL	C1-C2-C3-O3
2	A	711	GOL	O1-C1-C2-O2
2	A	711	GOL	O1-C1-C2-C3
2	A	711	GOL	C1-C2-C3-O3
2	A	712	GOL	C1-C2-C3-O3
2	A	706	GOL	O1-C1-C2-C3
2	A	710	GOL	O1-C1-C2-C3
2	A	713	GOL	O1-C1-C2-C3
2	A	707	GOL	O1-C1-C2-O2
2	A	711	GOL	O2-C2-C3-O3
2	A	712	GOL	O2-C2-C3-O3
2	A	713	GOL	O1-C1-C2-O2
2	A	703	GOL	O2-C2-C3-O3
2	A	706	GOL	O1-C1-C2-O2
2	A	707	GOL	O2-C2-C3-O3
2	A	710	GOL	O1-C1-C2-O2
2	A	702	GOL	O1-C1-C2-C3
2	A	702	GOL	O1-C1-C2-O2

There are no ring outliers.

3 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	708	GOL	1	0
2	A	713	GOL	2	0
2	A	706	GOL	1	0

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	A	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	A	133:GLN	C	134:LEU	N	1.19

6 Fit of model and data

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.