



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 12, 2026 – 03:19 PM UTC

PDB ID : 2ZUU / pdb_00002zuu
Title : Crystal structure of Galacto-N-biose/Lacto-N-biose I phosphorylase in complex with GlcNAc
Authors : Hidaka, M.; Nishimoto, M.; Kitaoka, M.; Wakagi, T.; Shoun, H.; Fushinobu, S.
Deposited on : 2008-10-28
Resolution : 2.30 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

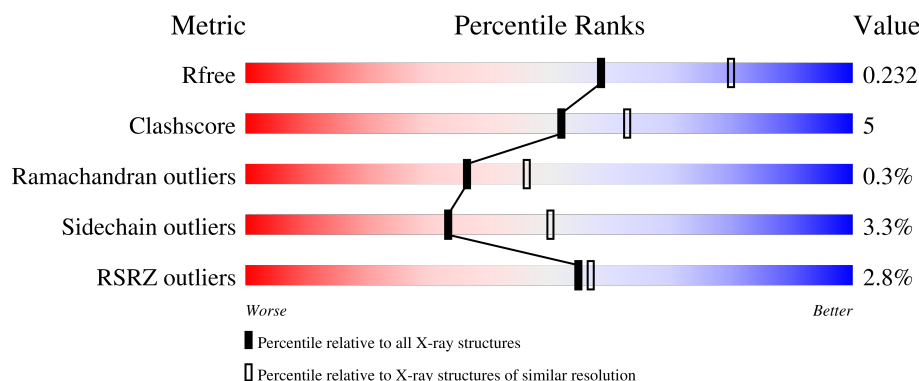
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.30 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	6319 (2.30-2.30)
Clashscore	190562	6919 (2.30-2.30)
Ramachandran outliers	187476	6854 (2.30-2.30)
Sidechain outliers	187428	6854 (2.30-2.30)
RSRZ outliers	180081	6325 (2.30-2.30)

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	759	5% 89% 9% ..
1	B	759	5% 80% 14% . .
1	C	759	89% 8% ..
1	D	759	5% 83% 13% ..

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
3	GOL	D	4008	-	-	X	-

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 25272 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 Lacto-N-biose phosphorylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	746	Total	C	N	O	S	0	0	0
			5934	3787	998	1133	16			
1	B	731	Total	C	N	O	S	0	0	0
			5813	3708	981	1108	16			
1	C	744	Total	C	N	O	S	0	0	0
			5920	3779	996	1129	16			
1	D	739	Total	C	N	O	S	0	0	0
			5882	3756	989	1121	16			

There are 32 discrepancies between the modelled and reference sequences:

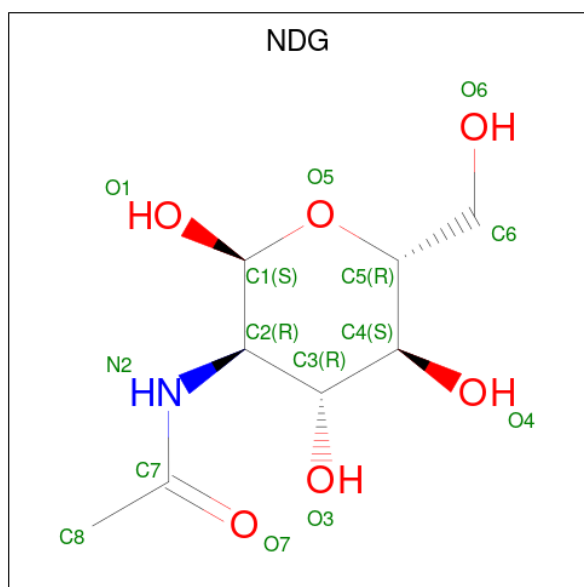
Chain	Residue	Modelled	Actual	Comment	Reference
A	752	LEU	-	expression tag	UNP Q5NU17
A	753	GLU	-	expression tag	UNP Q5NU17
A	754	HIS	-	expression tag	UNP Q5NU17
A	755	HIS	-	expression tag	UNP Q5NU17
A	756	HIS	-	expression tag	UNP Q5NU17
A	757	HIS	-	expression tag	UNP Q5NU17
A	758	HIS	-	expression tag	UNP Q5NU17
A	759	HIS	-	expression tag	UNP Q5NU17
B	752	LEU	-	expression tag	UNP Q5NU17
B	753	GLU	-	expression tag	UNP Q5NU17
B	754	HIS	-	expression tag	UNP Q5NU17
B	755	HIS	-	expression tag	UNP Q5NU17
B	756	HIS	-	expression tag	UNP Q5NU17
B	757	HIS	-	expression tag	UNP Q5NU17
B	758	HIS	-	expression tag	UNP Q5NU17
B	759	HIS	-	expression tag	UNP Q5NU17
C	752	LEU	-	expression tag	UNP Q5NU17
C	753	GLU	-	expression tag	UNP Q5NU17
C	754	HIS	-	expression tag	UNP Q5NU17
C	755	HIS	-	expression tag	UNP Q5NU17
C	756	HIS	-	expression tag	UNP Q5NU17

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Chain	Residue	Modelled	Actual	Comment	Reference
C	757	HIS	-	expression tag	UNP Q5NU17
C	758	HIS	-	expression tag	UNP Q5NU17
C	759	HIS	-	expression tag	UNP Q5NU17
D	752	LEU	-	expression tag	UNP Q5NU17
D	753	GLU	-	expression tag	UNP Q5NU17
D	754	HIS	-	expression tag	UNP Q5NU17
D	755	HIS	-	expression tag	UNP Q5NU17
D	756	HIS	-	expression tag	UNP Q5NU17
D	757	HIS	-	expression tag	UNP Q5NU17
D	758	HIS	-	expression tag	UNP Q5NU17
D	759	HIS	-	expression tag	UNP Q5NU17

- Molecule 2 is 2-acetamido-2-deoxy- α -D-glucopyranose (CCD ID: NDG) (formula: $C_8H_{15}NO_6$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			15	8	1	6		
2	B	1	Total	C	N	O	0	0
			15	8	1	6		
2	C	1	Total	C	N	O	0	0
			15	8	1	6		
2	D	1	Total	C	N	O	0	0
			15	8	1	6		

- Molecule 3 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



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

- Molecule 4 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	1	Total	Mg	0	0
			1	1		

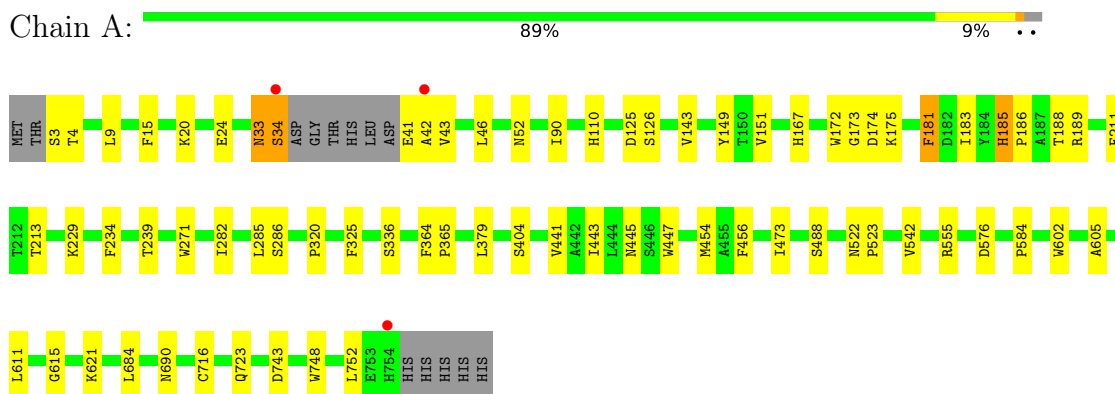
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	427	Total	O	0	0
			427	427		
5	B	368	Total	O	0	0
			368	368		
5	C	454	Total	O	0	0
			454	454		
5	D	389	Total	O	0	0
			389	389		

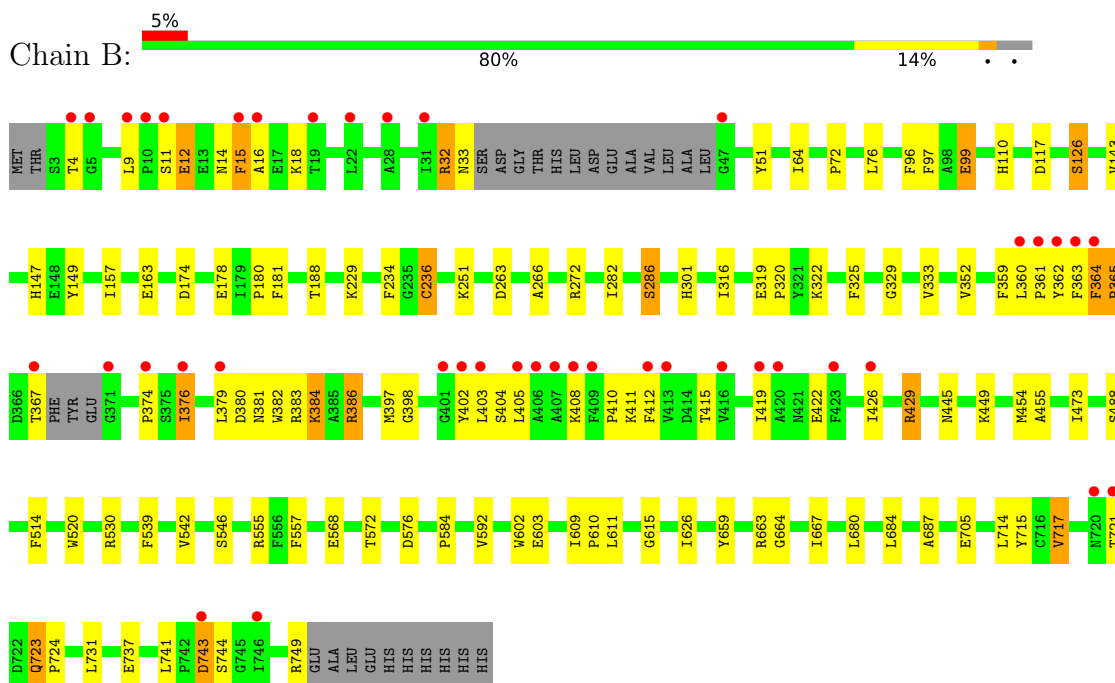
3 Residue-property plots

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.

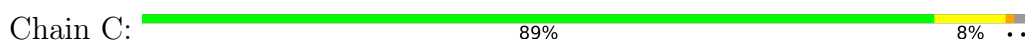
• Molecule 1: Lacto-N-biose phosphorylase

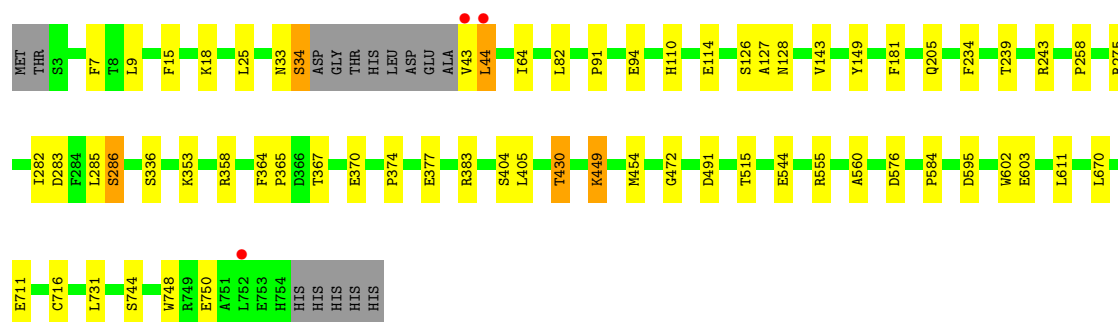


• Molecule 1: Lacto-N-biose phosphorylase

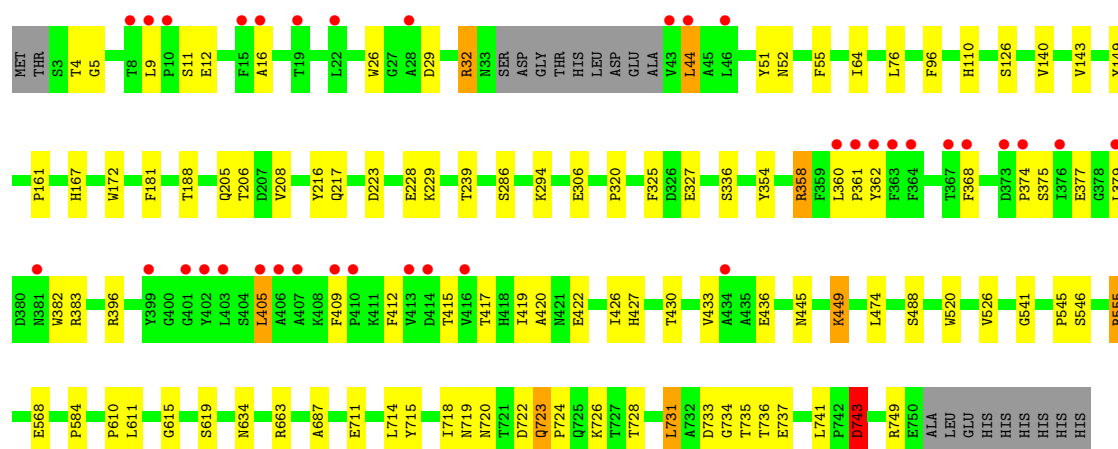
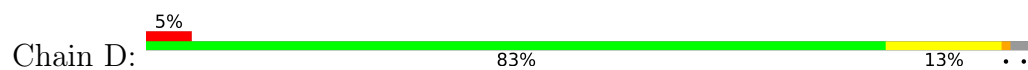


• Molecule 1: Lacto-N-biose phosphorylase





● Molecule 1: Lacto-N-biose phosphorylase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	67.78Å 111.48Å 118.43Å 105.19° 90.48° 107.35°	Depositor
Resolution (Å)	40.68 – 2.30 40.68 – 2.30	Depositor EDS
% Data completeness (in resolution range)	97.1 (40.68-2.30) 97.1 (40.68-2.30)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.64 (at 2.29Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.170 , 0.231 0.171 , 0.232	Depositor DCC
R_{free} test set	6869 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	31.2	Xtriage
Anisotropy	0.107	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 37.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.027 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	25272	wwPDB-VP
Average B, all atoms (Å ²)	35.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.47% 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: MG, NDG, 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	0.63	0/6102	0.84	2/8311 (0.0%)
1	B	0.62	0/5977	0.84	2/8139 (0.0%)
1	C	0.63	0/6088	0.83	0/8292
1	D	0.61	0/6049	0.83	3/8239 (0.0%)
All	All	0.63	0/24216	0.84	7/32981 (0.0%)

There are no bond length outliers.

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	185	HIS	CA-C-N	5.89	126.03	119.32
1	A	185	HIS	C-N-CA	5.89	126.03	119.32
1	D	16	ALA	N-CA-C	5.77	117.25	111.07
1	B	364	PHE	CA-C-N	5.39	126.58	119.84
1	B	364	PHE	C-N-CA	5.39	126.58	119.84

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	5934	0	5623	42	0
1	B	5813	0	5511	81	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	C	5920	0	5612	43	0
1	D	5882	0	5578	69	0
2	A	15	0	12	0	0
2	B	15	0	12	0	0
2	C	15	0	12	0	0
2	D	15	0	12	0	0
3	A	6	0	8	1	0
3	B	6	0	8	1	0
3	C	6	0	8	3	0
3	D	6	0	8	4	0
4	B	1	0	0	0	0
5	A	427	0	0	8	0
5	B	368	0	0	3	0
5	C	454	0	0	8	0
5	D	389	0	0	12	0
All	All	25272	0	22404	234	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 5.

The worst 5 of 234 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:D:420:ALA:HB3	5:D:1553:HOH:O	1.59	1.00
1:C:449:LYS:HB3	3:C:4007:GOL:H11	1.48	0.96
1:B:449:LYS:HB3	3:B:4006:GOL:H11	1.51	0.93
1:B:429:ARG:HG2	1:B:429:ARG:HH11	1.33	0.90
1:B:32:ARG:HD2	1:B:33:ASN:H	1.45	0.81

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	742/759 (98%)	714 (96%)	26 (4%)	2 (0%)	36	46
1	B	725/759 (96%)	686 (95%)	35 (5%)	4 (1%)	21	27
1	C	740/759 (98%)	712 (96%)	28 (4%)	0	100	100
1	D	735/759 (97%)	698 (95%)	35 (5%)	2 (0%)	36	46
All	All	2942/3036 (97%)	2810 (96%)	124 (4%)	8 (0%)	36	46

5 of 8 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	173	GLY
1	B	15	PHE
1	A	743	ASP
1	D	743	ASP
1	B	743	ASP

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	622/634 (98%)	609 (98%)	13 (2%)	47	66
1	B	610/634 (96%)	586 (96%)	24 (4%)	28	43
1	C	621/634 (98%)	604 (97%)	17 (3%)	39	58
1	D	617/634 (97%)	590 (96%)	27 (4%)	25	38
All	All	2470/2536 (97%)	2389 (97%)	81 (3%)	33	50

5 of 81 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	32	ARG
1	D	526	VAL
1	D	188	THR
1	D	358	ARG
1	D	723	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 26 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	170	ASN
1	D	52	ASN
1	D	690	ASN
1	C	720	ASN
1	D	128	ASN

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 ⓘ

Of 9 ligands modelled in this entry, 1 is monoatomic - leaving 8 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	$\# Z > 2$
2	NDG	C	4003	-	15,15,15	0.57	0	21,21,21	1.25	1 (4%)
2	NDG	D	4004	-	15,15,15	0.51	0	21,21,21	1.14	1 (4%)
2	NDG	B	4002	-	15,15,15	0.69	0	21,21,21	1.18	1 (4%)
2	NDG	A	4001	-	15,15,15	0.55	0	21,21,21	1.33	1 (4%)
3	GOL	B	4006	-	5,5,5	0.27	0	5,5,5	0.70	0
3	GOL	C	4007	-	5,5,5	0.28	0	5,5,5	0.99	1 (20%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
3	GOL	D	4008	-	5,5,5	0.35	0	5,5,5	0.85	0
3	GOL	A	4005	-	5,5,5	0.38	0	5,5,5	0.83	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	NDG	C	4003	-	-	0/6/26/26	0/1/1/1
2	NDG	D	4004	-	-	0/6/26/26	0/1/1/1
2	NDG	B	4002	-	-	0/6/26/26	0/1/1/1
2	NDG	A	4001	-	-	0/6/26/26	0/1/1/1
3	GOL	B	4006	-	-	2/4/4/4	-
3	GOL	C	4007	-	-	2/4/4/4	-
3	GOL	D	4008	-	-	4/4/4/4	-
3	GOL	A	4005	-	-	1/4/4/4	-

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	4001	NDG	C1-C2-N2	-4.86	105.10	110.73
2	C	4003	NDG	C1-C2-N2	-4.51	105.51	110.73
2	B	4002	NDG	C1-C2-N2	-3.27	106.94	110.73
2	D	4004	NDG	O5-C1-C2	3.26	112.79	109.52
3	C	4007	GOL	C3-C2-C1	-2.16	103.86	111.80

There are no chirality outliers.

5 of 9 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	4006	GOL	O1-C1-C2-C3
3	C	4007	GOL	O1-C1-C2-O2
3	C	4007	GOL	O1-C1-C2-C3
3	D	4008	GOL	O1-C1-C2-C3
3	D	4008	GOL	C1-C2-C3-O3

There are no ring outliers.

4 monomers are involved in 9 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	4006	GOL	1	0
3	C	4007	GOL	3	0
3	D	4008	GOL	4	0
3	A	4005	GOL	1	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](#)

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	746/759 (98%)	-0.35	3 (0%) 88 89	20, 30, 45, 73	0
1	B	731/759 (96%)	0.02	41 (5%) 30 32	22, 34, 71, 85	0
1	C	744/759 (98%)	-0.36	3 (0%) 88 89	20, 30, 46, 62	0
1	D	739/759 (97%)	-0.01	36 (4%) 35 36	19, 33, 64, 71	0
All	All	2960/3036 (97%)	-0.17	83 (2%) 55 57	19, 32, 61, 85	0

The worst 5 of 83 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	43	VAL	5.9
1	D	379	LEU	5.1
1	B	379	LEU	4.9
1	B	401	GLY	4.5
1	D	414	ASP	3.9

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($\text{\AA}^2$)	Q<0.9
3	GOL	D	4008	6/6	0.87	0.10	39,42,42,43	0
3	GOL	B	4006	6/6	0.89	0.10	46,47,47,48	0
3	GOL	C	4007	6/6	0.89	0.10	36,39,41,41	0
3	GOL	A	4005	6/6	0.89	0.10	30,34,35,37	0
4	MG	B	4009	1/1	0.94	0.05	36,36,36,36	0
2	NDG	B	4002	15/15	0.95	0.06	28,32,33,34	0
2	NDG	C	4003	15/15	0.96	0.06	27,28,31,31	0
2	NDG	A	4001	15/15	0.96	0.06	23,26,29,30	0
2	NDG	D	4004	15/15	0.97	0.04	27,30,32,33	0

6.5 Other polymers [i](#)

There are no such residues in this entry.