



Full wwPDB X-ray Structure Validation Report ⓘ

Apr 18, 2026 – 12:38 PM UTC

PDB ID : 2H3H / pdb_00002h3h
Title : Crystal structure of the liganded form of Thermotoga maritima glucose binding protein
Authors : Changela, A.; Tian, Y.
Deposited on : 2006-05-22
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) : 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

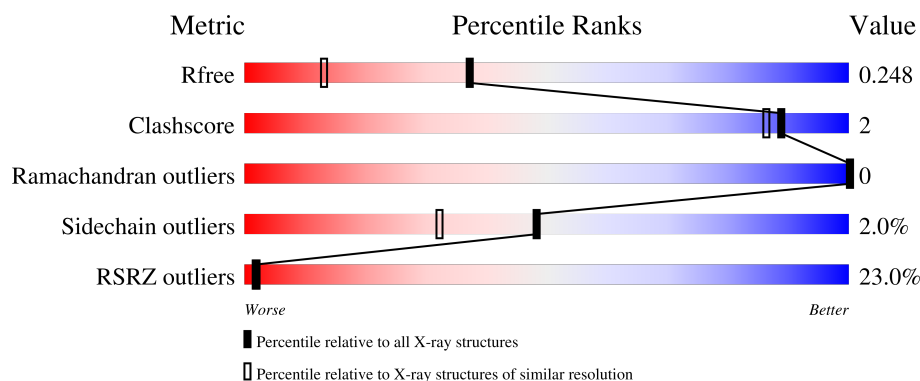
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 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))
R_{free}	180053	5551 (1.70-1.70)
Clashscore	190562	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)
RSRZ outliers	180081	5554 (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 $\leq 5\%$. 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	313	3% 97% .
1	B	313	42% 89% 8% .

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 5417 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 Sugar ABC transporter, periplasmic sugar-binding protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	313	Total	C	N	O	S	0	5	0
			2417	1545	395	463	14			
1	B	305	Total	C	N	O	S	0	0	0
			2308	1481	370	444	13			

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	initiating methionine	UNP Q9WXW9
A	306	GLY	-	cloning artifact	UNP Q9WXW9
A	307	SER	-	cloning artifact	UNP Q9WXW9
A	308	HIS	-	cloning artifact	UNP Q9WXW9
A	309	HIS	-	cloning artifact	UNP Q9WXW9
A	310	HIS	-	cloning artifact	UNP Q9WXW9
A	311	HIS	-	cloning artifact	UNP Q9WXW9
A	312	HIS	-	cloning artifact	UNP Q9WXW9
A	313	HIS	-	cloning artifact	UNP Q9WXW9
B	1	MET	-	initiating methionine	UNP Q9WXW9
B	306	GLY	-	cloning artifact	UNP Q9WXW9
B	307	SER	-	cloning artifact	UNP Q9WXW9
B	308	HIS	-	cloning artifact	UNP Q9WXW9
B	309	HIS	-	cloning artifact	UNP Q9WXW9
B	310	HIS	-	cloning artifact	UNP Q9WXW9
B	311	HIS	-	cloning artifact	UNP Q9WXW9
B	312	HIS	-	cloning artifact	UNP Q9WXW9
B	313	HIS	-	cloning artifact	UNP Q9WXW9

- Molecule 2 is beta-D-glucopyranose (CCD ID: BGC) (formula: C₆H₁₂O₆).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			12	6	6		
2	B	1	Total	C	O	0	0
			12	6	6		

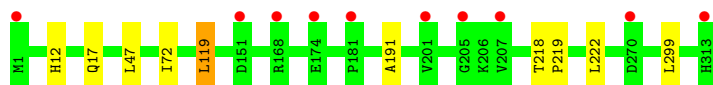
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	460	Total	O	0	0
			460	460		
3	B	208	Total	O	0	0
			208	208		

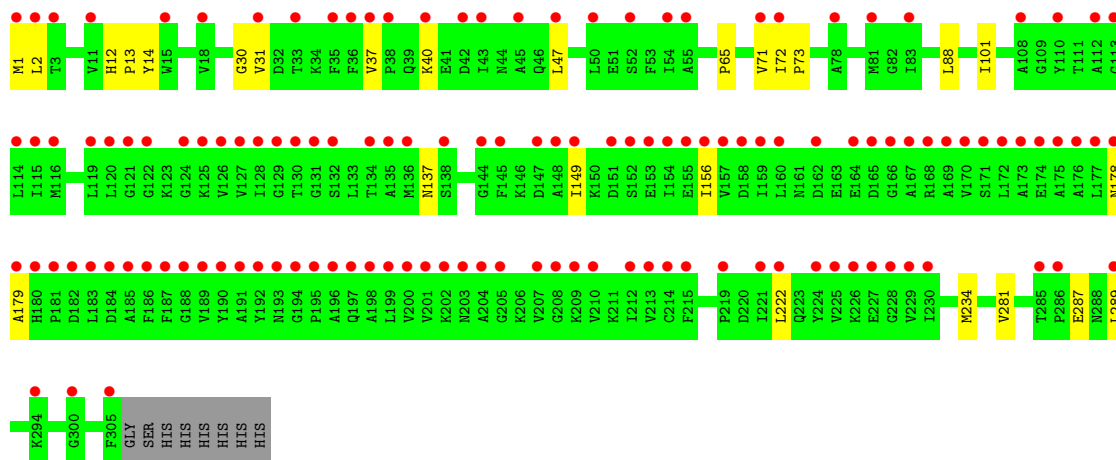
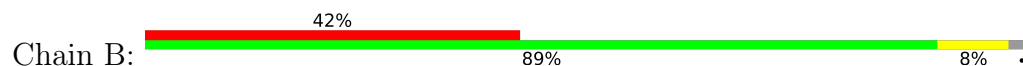
3 Residue-property plots

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: Sugar ABC transporter, periplasmic sugar-binding protein



- Molecule 1: Sugar ABC transporter, periplasmic sugar-binding protein



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	148.20Å 46.06Å 118.40Å 90.00° 108.22° 90.00°	Depositor
Resolution (Å)	50.00 – 1.70 50.00 – 1.70	Depositor EDS
% Data completeness (in resolution range)	95.1 (50.00-1.70) 95.1 (50.00-1.70)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.93 (at 1.70Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.203 , 0.241 0.210 , 0.248	Depositor DCC
R_{free} test set	4030 reflections (4.79%)	wwPDB-VP
Wilson B-factor (Å ²)	18.8	Xtriage
Anisotropy	0.192	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 52.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	5417	wwPDB-VP
Average B, all atoms (Å ²)	30.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.05% 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: BGC

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	0.71	1/2461 (0.0%)	0.82	0/3337
1	B	0.53	0/2346	0.76	0/3180
All	All	0.63	1/4807 (0.0%)	0.79	0/6517

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	72	ILE	CA-CB	8.08	1.58	1.54

There are no bond angle outliers.

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	2417	0	2446	7	0
1	B	2308	0	2365	11	0
2	A	12	0	12	0	0
2	B	12	0	12	0	0
3	A	460	0	0	5	0
3	B	208	0	0	0	0
All	All	5417	0	4835	18	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 2.

All (18) 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:218[A]:THR:HG23	3:A:1935:HOH:O	1.93	0.68
1:A:17:GLN:NE2	3:A:1935:HOH:O	2.27	0.67
1:B:149:ILE:HD11	1:B:156:ILE:HD11	1.83	0.60
1:A:218[A]:THR:CG2	3:A:1935:HOH:O	2.54	0.55
1:B:2:LEU:HB2	1:B:31:VAL:HG23	1.91	0.53
1:B:12:HIS:CD2	1:B:14:TYR:H	2.31	0.49
1:B:12:HIS:HD2	1:B:14:TYR:H	1.58	0.49
1:B:178:ASN:OD1	1:B:179:ALA:N	2.46	0.49
1:B:1:MET:HE2	1:B:30:GLY:C	2.39	0.47
1:A:12:HIS:CE1	1:A:191:ALA:HB1	2.53	0.44
1:B:72:ILE:HB	1:B:73:PRO:HD3	2.00	0.42
1:A:119:LEU:HD13	3:A:1644:HOH:O	2.20	0.42
1:B:12:HIS:CG	1:B:13:PRO:HD2	2.55	0.41
1:B:65:PRO:HB3	1:B:71:VAL:HG11	2.03	0.41
1:A:299:LEU:HD22	3:A:1709:HOH:O	2.21	0.41
1:A:218[B]:THR:HG22	1:A:219:PRO:HD2	2.02	0.41
1:B:88:LEU:HA	1:B:101:ILE:O	2.20	0.41
1:B:234:MET:HE3	1:B:281:VAL:HG21	2.03	0.41

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	316/313 (101%)	308 (98%)	8 (2%)	0	100	100
1	B	303/313 (97%)	295 (97%)	8 (3%)	0	100	100
All	All	619/626 (99%)	603 (97%)	16 (3%)	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	262/257 (102%)	259 (99%)	3 (1%)	65	54
1	B	250/257 (97%)	243 (97%)	7 (3%)	38	21
All	All	512/514 (100%)	502 (98%)	10 (2%)	48	32

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	47	LEU
1	A	119	LEU
1	A	222	LEU
1	B	37	VAL
1	B	40	LYS
1	B	47	LEU
1	B	137	ASN
1	B	222	LEU
1	B	287	GLU
1	B	289	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (9) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	308	HIS
1	A	310	HIS
1	A	311	HIS
1	A	313	HIS
1	B	39	GLN
1	B	48	GLN
1	B	137	ASN
1	B	180	HIS
1	B	236	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 ⓘ

2 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	BGC	B	1501	-	12,12,12	0.59	0	17,17,17	0.88	0
2	BGC	A	1500	-	12,12,12	0.61	0	17,17,17	1.19	2 (11%)

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	BGC	B	1501	-	-	0/2/22/22	0/1/1/1
2	BGC	A	1500	-	-	0/2/22/22	0/1/1/1

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
2	A	1500	BGC	C3-C4-C5	-2.75	105.24	110.23
2	A	1500	BGC	O4-C4-C5	2.25	114.86	109.32

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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

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(Å ²)	Q<0.9
1	A	313/313 (100%)	0.14	10 (3%)	50 54	8, 18, 34, 38	5 (1%)
1	B	305/313 (97%)	1.95	132 (43%)	0 0	16, 40, 60, 63	0
All	All	618/626 (98%)	1.04	142 (22%)	2 2	8, 26, 58, 63	5 (0%)

All (142) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	127	VAL	6.2
1	B	177	LEU	6.2
1	B	200	VAL	5.9
1	B	183	LEU	5.6
1	B	171	SER	5.5
1	B	170	VAL	5.3
1	B	176	ALA	5.3
1	B	157	VAL	5.2
1	B	198	ALA	5.0
1	B	175	ALA	5.0
1	B	210	VAL	4.9
1	B	172	LEU	4.9
1	B	191	ALA	4.5
1	B	173	ALA	4.5
1	B	167	ALA	4.4
1	B	207	VAL	4.4
1	B	149	ILE	4.4
1	B	201	VAL	4.2
1	B	225	VAL	4.2
1	B	185	ALA	4.2
1	B	204	ALA	4.1
1	B	115	ILE	4.1
1	B	154	ILE	4.1
1	B	169	ALA	4.1

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Mol	Chain	Res	Type	RSRZ
1	B	199	LEU	4.1
1	B	186	PHE	4.1
1	B	126	VAL	4.0
1	B	188	GLY	4.0
1	B	189	VAL	4.0
1	B	222	LEU	3.9
1	B	178	ASN	3.9
1	B	11	VAL	3.9
1	B	190	TYR	3.9
1	B	55	ALA	3.9
1	B	179	ALA	3.9
1	B	196	ALA	3.8
1	B	202	LYS	3.8
1	B	212	ILE	3.8
1	B	214	CYS	3.8
1	B	305	PHE	3.7
1	B	128	ILE	3.7
1	B	213	VAL	3.7
1	B	156	ILE	3.7
1	B	1	MET	3.7
1	B	120	LEU	3.6
1	B	160	LEU	3.6
1	B	205	GLY	3.6
1	B	181	PRO	3.5
1	B	131	GLY	3.5
1	B	119	LEU	3.5
1	B	182	ASP	3.4
1	B	130	THR	3.4
1	B	224	TYR	3.4
1	B	174	GLU	3.4
1	B	148	ALA	3.3
1	B	52	SER	3.3
1	B	2	LEU	3.3
1	B	159	ILE	3.2
1	B	112	ALA	3.2
1	B	230	ILE	3.2
1	B	164	GLU	3.2
1	B	124	GLY	3.2
1	B	134	THR	3.2
1	B	192	TYR	3.1
1	B	166	GLY	3.1
1	A	151	ASP	3.1

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Mol	Chain	Res	Type	RSRZ
1	B	197	GLN	3.0
1	B	45	ALA	3.0
1	B	180	HIS	3.0
1	B	203	ASN	3.0
1	B	81	MET	3.0
1	B	187	PHE	3.0
1	B	215	PHE	2.9
1	B	208	GLY	2.9
1	B	227	GLU	2.9
1	B	145	PHE	2.9
1	B	219	PRO	2.9
1	B	165	ASP	2.8
1	B	152	SER	2.8
1	B	195	PRO	2.8
1	B	50	LEU	2.8
1	B	72	ILE	2.8
1	B	37	VAL	2.8
1	B	300	GLY	2.8
1	B	162	ASP	2.7
1	B	114	LEU	2.7
1	B	158	ASP	2.7
1	B	36	PHE	2.7
1	B	155	GLU	2.7
1	B	285	THR	2.7
1	B	113	GLY	2.7
1	B	194	GLY	2.7
1	B	43	ILE	2.7
1	B	31	VAL	2.6
1	B	229	VAL	2.6
1	B	135	ALA	2.6
1	B	116	MET	2.6
1	B	129	GLY	2.6
1	A	270	ASP	2.6
1	B	221	ILE	2.6
1	B	193	ASN	2.6
1	B	121	GLY	2.5
1	B	35	PHE	2.5
1	A	201	VAL	2.5
1	B	38	PRO	2.5
1	B	108	ALA	2.5
1	B	18	VAL	2.5
1	B	71	VAL	2.5

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Mol	Chain	Res	Type	RSRZ
1	B	3	THR	2.5
1	B	47	LEU	2.4
1	B	54	ILE	2.4
1	B	132	SER	2.4
1	B	78	ALA	2.4
1	B	153	GLU	2.4
1	B	125	LYS	2.4
1	A	207	VAL	2.4
1	A	1	MET	2.4
1	A	313	HIS	2.4
1	B	294	LYS	2.3
1	B	228	GLY	2.3
1	A	168	ARG	2.3
1	B	147	ASP	2.3
1	B	136	MET	2.3
1	B	151	ASP	2.2
1	B	110	TYR	2.2
1	B	168	ARG	2.2
1	B	289	LEU	2.2
1	B	286	PRO	2.2
1	B	15	TRP	2.2
1	A	181	PRO	2.2
1	B	33	THR	2.2
1	B	184	ASP	2.1
1	A	205	GLY	2.1
1	B	122	GLY	2.1
1	A	174	GLU	2.1
1	B	40	LYS	2.1
1	B	83	ILE	2.1
1	B	144	GLY	2.0
1	B	209	LYS	2.0
1	B	42	ASP	2.0
1	B	138	SER	2.0
1	B	226	LYS	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 [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
2	BGC	B	1501	12/12	0.90	0.12	28,29,32,34	0
2	BGC	A	1500	12/12	0.98	0.04	10,11,12,14	0

6.5 Other polymers [i](#)

There are no such residues in this entry.