



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 11, 2021 – 08:12 AM EDT

PDB ID : 2REG  
Title : ABC-transporter choline binding protein in complex with choline  
Authors : Oswald, C.; Schimtt, L.; Smits, S.H.J.; Hoeing, M.; Sohn-Boeser, L.; Bremer, E.  
Deposited on : 2007-09-26  
Resolution : 1.90 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](mailto: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.

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

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtrriage (Phenix) : 1.13  
EDS : 2.23.2  
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) : 2.23.2

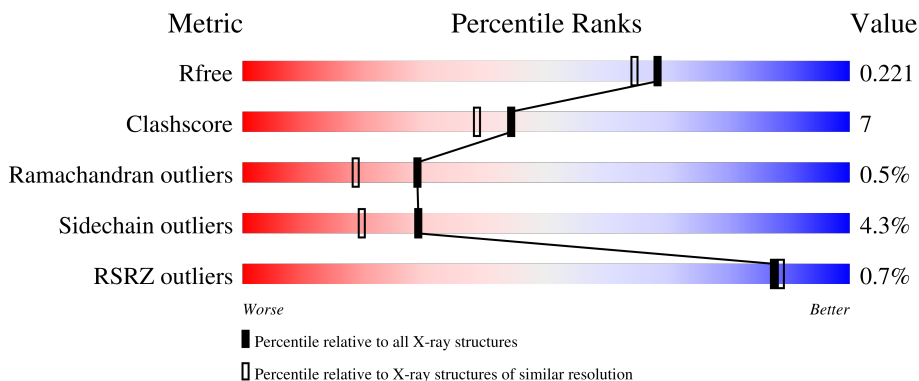
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.90 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))
$R_{free}$	130704	6207 (1.90-1.90)
Clashscore	141614	6847 (1.90-1.90)
Ramachandran outliers	138981	6760 (1.90-1.90)
Sidechain outliers	138945	6760 (1.90-1.90)
RSRZ outliers	127900	6082 (1.90-1.90)

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  $\geq 3$ , 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	298	 82% 13% ..
1	B	298	 % 78% 18% ..

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 4753 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.

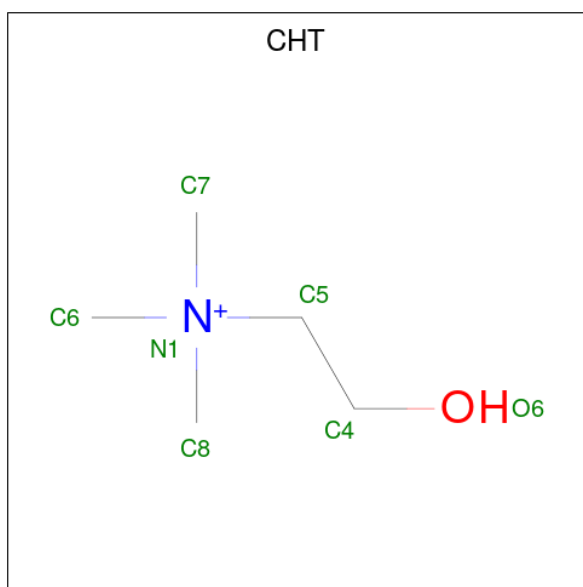
- Molecule 1 is a protein called PUTATIVE GLYCINE BETAIN-BINDING ABC TRANSPORTER PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	290	2256	1418	368	460	10	0	8	0
1	B	289	2214	1394	360	451	9	0	4	0

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	251	ASP	GLY	engineered mutation	UNP Q92N37
A	319	GLU	-	expression tag	UNP Q92N37
A	320	HIS	-	expression tag	UNP Q92N37
A	321	HIS	-	expression tag	UNP Q92N37
A	322	HIS	-	expression tag	UNP Q92N37
A	323	HIS	-	expression tag	UNP Q92N37
A	324	HIS	-	expression tag	UNP Q92N37
A	325	HIS	-	expression tag	UNP Q92N37
B	251	ASP	GLY	engineered mutation	UNP Q92N37
B	319	GLU	-	expression tag	UNP Q92N37
B	320	HIS	-	expression tag	UNP Q92N37
B	321	HIS	-	expression tag	UNP Q92N37
B	322	HIS	-	expression tag	UNP Q92N37
B	323	HIS	-	expression tag	UNP Q92N37
B	324	HIS	-	expression tag	UNP Q92N37
B	325	HIS	-	expression tag	UNP Q92N37

- Molecule 2 is CHOLINE ION (three-letter code: CHT) (formula: C<sub>5</sub>H<sub>14</sub>NO).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
2	A	1	7	5	1	1	0	0
2	B	1	7	5	1	1	0	0


- Molecule 3 is water.

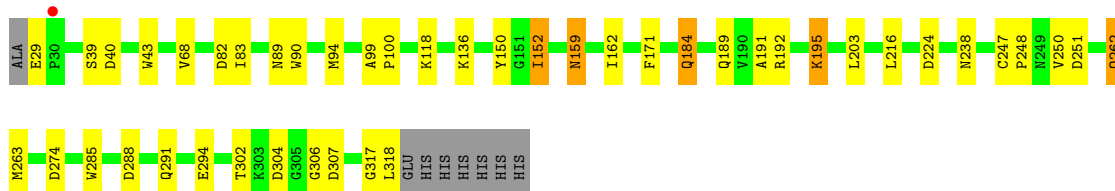
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	A	156	156	156	0	0
3	B	113	113	113	0	0

### 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.

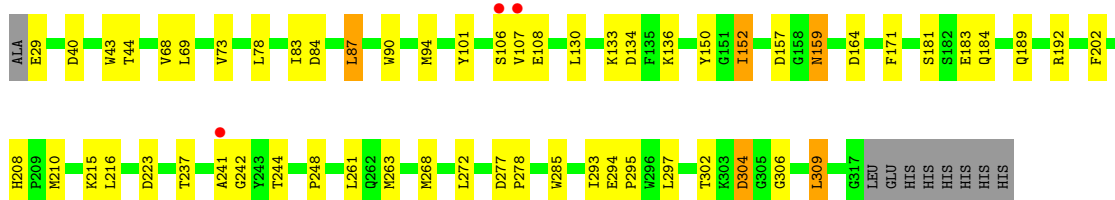
- Molecule 1: PUTATIVE GLYCINE BETAIN-BINDING ABC TRANSPORTER PROTEIN

Chain A: 



- Molecule 1: PUTATIVE GLYCINE BETAIN-BINDING ABC TRANSPORTER PROTEIN

Chain B: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	30.80Å 185.41Å 42.53Å 90.00° 91.83° 90.00°	Depositor
Resolution (Å)	20.00 – 1.90 19.58 – 1.90	Depositor EDS
% Data completeness (in resolution range)	90.2 (20.00-1.90) 90.2 (19.58-1.90)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.04	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.37 (at 1.90Å)	Xtrriage
Refinement program	REFMAC 5.2.0003	Depositor
R, $R_{free}$	0.180 , 0.222 0.180 , 0.221	Depositor DCC
$R_{free}$ test set	1687 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	24.0	Xtrriage
Anisotropy	0.135	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 23.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtrriage
Estimated twinning fraction	0.115 for h,-k,-l	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	4753	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	18.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.20% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: CHT

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	0/2314	0.74	8/3141 (0.3%)
1	B	0.35	0/2265	0.76	7/3074 (0.2%)
All	All	0.36	0/4579	0.75	15/6215 (0.2%)

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	B	0	1

There are no bond length outliers.

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	B	223	ASP	CB-CG-OD2	6.09	123.78	118.30
1	A	224	ASP	CB-CG-OD2	5.57	123.31	118.30
1	A	82	ASP	CB-CG-OD2	5.56	123.30	118.30
1	A	251	ASP	CB-CG-OD2	5.43	123.19	118.30
1	B	164[A]	ASP	CB-CG-OD2	5.41	123.17	118.30
1	B	164[B]	ASP	CB-CG-OD2	5.41	123.17	118.30
1	A	304[A]	ASP	CB-CG-OD2	5.25	123.03	118.30
1	A	304[B]	ASP	CB-CG-OD2	5.25	123.03	118.30
1	B	157	ASP	CB-CG-OD2	5.20	122.98	118.30
1	A	288	ASP	CB-CG-OD2	5.19	122.97	118.30
1	A	307	ASP	CB-CG-OD2	5.18	122.96	118.30
1	B	134	ASP	CB-CG-OD2	5.07	122.86	118.30
1	B	304	ASP	CB-CG-OD2	5.05	122.85	118.30
1	A	274	ASP	CB-CG-OD2	5.03	122.83	118.30

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Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	B	84	ASP	CB-CG-OD2	5.01	122.81	118.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	106	SER	Peptide

## 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	2256	0	2184	24	0
1	B	2214	0	2155	34	0
2	A	7	0	14	0	0
2	B	7	0	14	0	0
3	A	156	0	0	0	0
3	B	113	0	0	0	0
All	All	4753	0	4367	58	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 7.

All (58) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance ( $\text{\AA}$ )	Clash overlap ( $\text{\AA}$ )
1:B:241:ALA:CB	1:B:242:GLY:HA3	1.79	1.07
1:B:241:ALA:HB1	1:B:242:GLY:HA3	1.11	1.06
1:B:302:THR:HG22	1:B:306:GLY:H	1.30	0.95
1:B:152:ILE:H	1:B:159:ASN:HD21	1.14	0.95
1:A:152:ILE:H	1:A:159:ASN:HD21	1.19	0.87
1:B:208:HIS:HD2	1:B:210:MET:H	1.22	0.83
1:B:241:ALA:CB	1:B:242:GLY:CA	2.57	0.81
1:B:241:ALA:HB1	1:B:242:GLY:CA	2.05	0.79
1:A:262[A]:GLN:HG2	1:A:263[A]:MET:N	2.00	0.76

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:263:MET:HG3	1:B:285:TRP:CH2	2.27	0.70
1:A:191:ALA:O	1:A:195:LYS:HD2	1.91	0.70
1:B:208:HIS:CD2	1:B:210:MET:H	2.07	0.69
1:A:189:GLN:HE21	1:A:192:ARG:HH21	1.46	0.63
1:B:302:THR:HG22	1:B:306:GLY:N	2.10	0.62
1:A:302:THR:HG22	1:A:306:GLY:H	1.65	0.59
1:B:263:MET:HG3	1:B:285:TRP:CZ2	2.39	0.58
1:B:150:TYR:CE2	1:B:189:GLN:HG2	2.38	0.58
1:B:152:ILE:N	1:B:159:ASN:HD21	1.94	0.58
1:A:262[A]:GLN:HG2	1:A:263[A]:MET:H	1.67	0.58
1:B:184:GLN:NE2	1:B:184:GLN:H	2.02	0.58
1:A:317:GLY:O	1:A:318:LEU:HB2	2.02	0.58
1:A:189:GLN:NE2	1:A:192:ARG:HH21	2.02	0.57
1:A:262[A]:GLN:CG	1:A:263[A]:MET:N	2.68	0.57
1:B:183:GLU:OE2	1:B:208:HIS:HE1	1.89	0.56
1:B:29:GLU:HG2	1:B:248:PRO:HD2	1.88	0.55
1:A:184[A]:GLN:NE2	1:A:184[A]:GLN:H	2.06	0.53
1:A:90:TRP:O	1:A:94:MET:HB2	2.09	0.52
1:B:302:THR:HG23	1:B:304:ASP:H	1.73	0.52
1:B:294:GLU:HB2	1:B:295:PRO:HD3	1.90	0.51
1:A:302:THR:HG22	1:A:306:GLY:N	2.26	0.51
1:B:87:LEU:HD12	1:B:237:THR:HG23	1.93	0.51
1:B:136:LYS:HD2	1:B:171:PHE:HD2	1.75	0.50
1:A:89:ASN:HB2	1:A:238:ASN:ND2	2.26	0.50
1:B:40:ASP:O	1:B:68:VAL:HA	2.11	0.50
1:A:152:ILE:N	1:A:159:ASN:HD21	1.99	0.50
1:B:208:HIS:HD2	1:B:210:MET:N	2.01	0.48
1:B:107:VAL:HG12	1:B:108:GLU:N	2.30	0.46
1:A:39:SER:HB2	1:A:83:ILE:HD13	1.98	0.46
1:A:89:ASN:HB2	1:A:238:ASN:HD21	1.81	0.46
1:A:29:GLU:HG2	1:A:248:PRO:HD2	1.99	0.45
1:A:40:ASP:O	1:A:68:VAL:HA	2.16	0.45
1:B:44:THR:HG21	1:B:272:LEU:HG	1.98	0.45
1:A:247:CYS:HB3	1:A:250:VAL:CG1	2.47	0.45
1:B:69:LEU:HG	1:B:73:VAL:HG12	1.98	0.45
1:B:90:TRP:O	1:B:94:MET:HB2	2.16	0.45
1:B:101:TYR:HB3	1:B:107:VAL:HG23	2.00	0.44
1:A:263[A]:MET:HB2	1:A:285:TRP:CZ2	2.53	0.44
1:B:78:LEU:HD13	1:B:107:VAL:HG11	1.99	0.44
1:A:99:ALA:HB3	1:A:100:PRO:HD3	2.01	0.43
1:A:136:LYS:HD2	1:A:171:PHE:HD2	1.84	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:297:LEU:HD13	1:B:309:LEU:HA	2.01	0.43
1:B:202:PHE:HZ	1:B:216:LEU:HD22	1.84	0.42
1:A:150:TYR:CE2	1:A:189:GLN:HG2	2.54	0.42
1:B:44:THR:HG22	1:B:268:MET:HG2	2.00	0.42
1:B:302:THR:CG2	1:B:306:GLY:H	2.16	0.42
1:B:189:GLN:HE21	1:B:192:ARG:HH11	1.68	0.41
1:A:162:ILE:HD11	1:A:203:LEU:HD21	2.03	0.41
1:B:277:ASP:HA	1:B:278:PRO:HD3	1.98	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	297/298 (100%)	292 (98%)	4 (1%)	1 (0%)	41	31
1	B	291/298 (98%)	284 (98%)	5 (2%)	2 (1%)	22	12
All	All	588/596 (99%)	576 (98%)	9 (2%)	3 (0%)	29	18

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	152	ILE
1	B	152	ILE
1	B	181	SER

#### 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	242/240 (101%)	229 (95%)	13 (5%)	22	13
1	B	236/240 (98%)	224 (95%)	12 (5%)	24	14
All	All	478/480 (100%)	453 (95%)	25 (5%)	29	14

All (25) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	43	TRP
1	A	118	LYS
1	A	159	ASN
1	A	184[A]	GLN
1	A	184[B]	GLN
1	A	195	LYS
1	A	216	LEU
1	A	262[A]	GLN
1	A	262[C]	GLN
1	A	262[B]	GLN
1	A	291[A]	GLN
1	A	291[B]	GLN
1	A	294	GLU
1	B	43	TRP
1	B	83	ILE
1	B	87	LEU
1	B	130	LEU
1	B	133	LYS
1	B	159	ASN
1	B	215[A]	LYS
1	B	215[B]	LYS
1	B	244	THR
1	B	261	LEU
1	B	293	ILE
1	B	309	LEU

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	89	ASN
1	A	159	ASN

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Mol	Chain	Res	Type
1	A	189	GLN
1	A	238	ASN
1	A	255	GLN
1	B	89	ASN
1	B	159	ASN
1	B	184	GLN
1	B	189	GLN
1	B	208	HIS
1	B	213	ASN
1	B	238	ASN

### 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](#)

There are no monosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

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	CHT	B	1	-	6,6,6	0.71	0	8,8,8	0.63	0
2	CHT	A	1	-	6,6,6	0.72	0	8,8,8	0.71	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	CHT	B	1	-	-	0/4/4/4	-
2	CHT	A	1	-	-	0/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

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 [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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	290/298 (97%)	-0.48	1 (0%) 94 94	7, 15, 25, 35	0
1	B	289/298 (96%)	-0.26	3 (1%) 82 84	14, 20, 28, 37	0
All	All	579/596 (97%)	-0.37	4 (0%) 87 88	7, 18, 27, 37	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	106	SER	4.0
1	B	241	ALA	3.4
1	A	30	PRO	3.2
1	B	107	VAL	2.8

### 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 monosaccharides 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, 95<sup>th</sup> 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(Å <sup>2</sup> )	Q<0.9
2	CHT	A	1	7/7	0.97	0.07	4,5,7,8	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
2	CHT	B	1	7/7	0.99	0.07	5,6,8,9	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.