Full wwPDB X-ray Structure Validation Report (i)

Aug 6, 2020 – 07:55 PM BST

PDB ID	:	5CI5
Title	:	Crystal Structure of an ABC transporter Solute Binding Protein from Thermotoga Lettingae TMO (Tlet_1705, TARGET EFI-510544) bound with alpha-D-Tagatose
Authors	:	Yadava, U.; Vetting, M.W.; Al Obaidi, N.F.; Toro, R.; Morisco, L.L.; Benach, J.; Koss, J.; Wasserman, S.R.; Attonito, J.D.; Scott Glenn, A.; Chamala, S.; Chowdhury, S.; Lafleur, J.; Love, J.; Seidel, R.D.; Whalen, K.L.; Gerlt, J.A.; Almo, S.C.; Enzyme Function Initiative (EFI)
Deposited on	:	2015-07-11
Resolution	:	1.61 Å(reported)

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

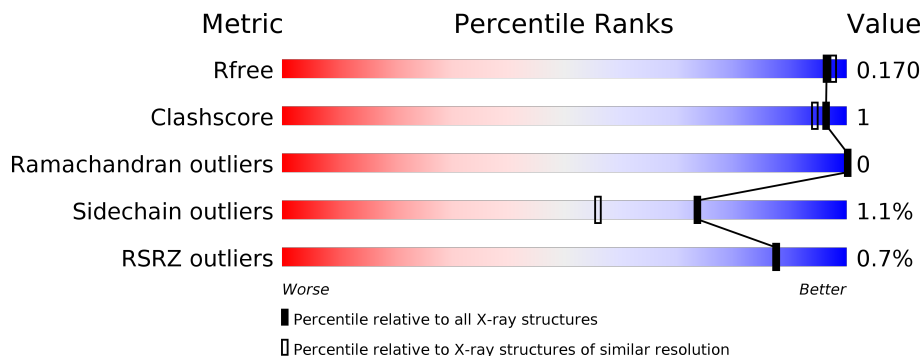|		
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.13.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.13.1

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 1.61 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	Percentile Ranks	Value
Rfree		0.170
Clashscore		1
Ramachandran outliers		0
Sidechain outliers		1.1%
RSRZ outliers		0.7%

Worse   *Better*

■ Percentile relative to all X-ray structures

▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	4693 (1.64-1.60)
Clashscore	141614	5002 (1.64-1.60)
Ramachandran outliers	138981	4888 (1.64-1.60)
Sidechain outliers	138945	4887 (1.64-1.60)
RSRZ outliers	127900	4609 (1.64-1.60)

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 on 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% 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	415	93% • 5%
1	B	415	90% • 6%

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 13645 atoms, of which 6262 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 Extracellular solute-binding protein family 1.

Mol	Chain	Residues	Atoms							ZeroOcc	AltConf	Trace
1	A	393	Total 6261	C 2049	H 3110	N 506	O 581	S 2	Se 13	0	3	0
1	B	392	Total 6245	C 2043	H 3100	N 506	O 582	S 2	Se 12	0	5	0

There are 42 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	MSE	-	expression tag	UNP A8F7X5
A	-1	HIS	-	expression tag	UNP A8F7X5
A	0	HIS	-	expression tag	UNP A8F7X5
A	1	HIS	-	expression tag	UNP A8F7X5
A	2	HIS	-	expression tag	UNP A8F7X5
A	3	HIS	-	expression tag	UNP A8F7X5
A	4	HIS	-	expression tag	UNP A8F7X5
A	5	SER	-	expression tag	UNP A8F7X5
A	6	SER	-	expression tag	UNP A8F7X5
A	7	GLY	-	expression tag	UNP A8F7X5
A	8	VAL	-	expression tag	UNP A8F7X5
A	9	ASP	-	expression tag	UNP A8F7X5
A	10	LEU	-	expression tag	UNP A8F7X5
A	11	GLY	-	expression tag	UNP A8F7X5
A	12	THR	-	expression tag	UNP A8F7X5
A	13	GLU	-	expression tag	UNP A8F7X5
A	14	ASN	-	expression tag	UNP A8F7X5
A	15	LEU	-	expression tag	UNP A8F7X5
A	16	TYR	-	expression tag	UNP A8F7X5
A	17	PHE	-	expression tag	UNP A8F7X5
A	18	GLN	-	expression tag	UNP A8F7X5
B	-2	MSE	-	expression tag	UNP A8F7X5
B	-1	HIS	-	expression tag	UNP A8F7X5
B	0	HIS	-	expression tag	UNP A8F7X5
B	1	HIS	-	expression tag	UNP A8F7X5

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Chain	Residue	Modelled	Actual	Comment	Reference
B	2	HIS	-	expression tag	UNP A8F7X5
B	3	HIS	-	expression tag	UNP A8F7X5
B	4	HIS	-	expression tag	UNP A8F7X5
B	5	SER	-	expression tag	UNP A8F7X5
B	6	SER	-	expression tag	UNP A8F7X5
B	7	GLY	-	expression tag	UNP A8F7X5
B	8	VAL	-	expression tag	UNP A8F7X5
B	9	ASP	-	expression tag	UNP A8F7X5
B	10	LEU	-	expression tag	UNP A8F7X5
B	11	GLY	-	expression tag	UNP A8F7X5
B	12	THR	-	expression tag	UNP A8F7X5
B	13	GLU	-	expression tag	UNP A8F7X5
B	14	ASN	-	expression tag	UNP A8F7X5
B	15	LEU	-	expression tag	UNP A8F7X5
B	16	TYR	-	expression tag	UNP A8F7X5
B	17	PHE	-	expression tag	UNP A8F7X5
B	18	GLN	-	expression tag	UNP A8F7X5

- Molecule 2 is alpha-D-tagatopyranose (three-letter code: T6T) (formula: $C_6H_{12}O_6$).
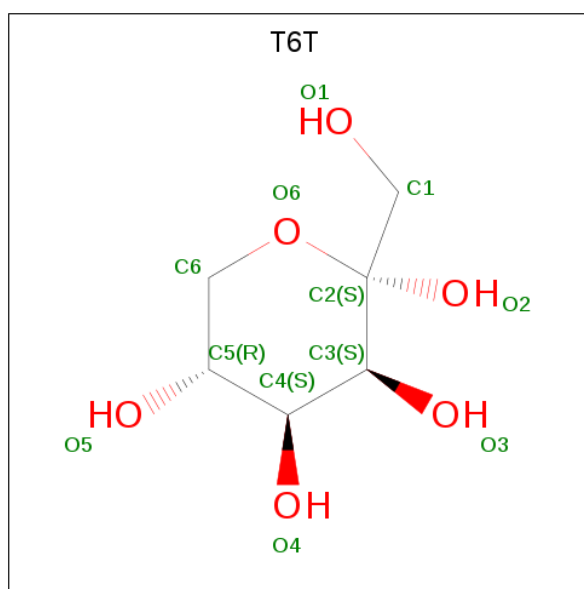
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	H	O	0	0
			24	6	12	6		
2	B	1	Total	C	H	O	0	0
			24	6	12	6		

- Molecule 3 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: $C_2H_6O_2$).

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	B	1	Total 10	C 2	H 6	O 2	0	0

- Molecule 4 is PENTAETHYLENE GLYCOL (three-letter code: 1PE) (formula: $C_{10}H_{22}O_6$).
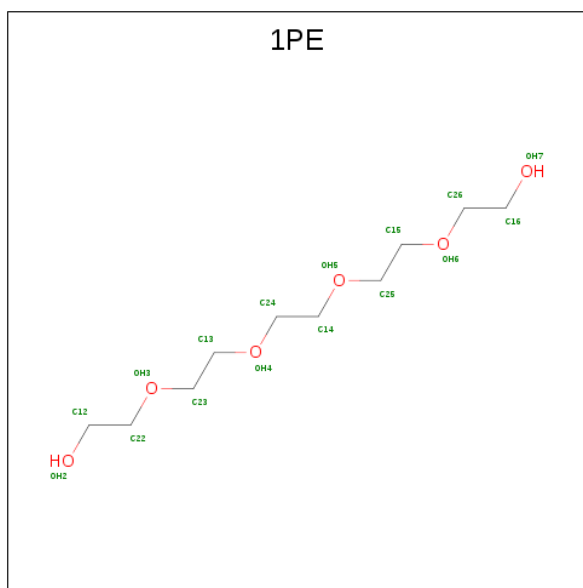
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	B	1	Total 38	C 10	H 22	O 6	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	550	Total 554	O 554	0	4
5	B	486	Total 489	O 489	0	3

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 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: Extracellular solute-binding protein family 1

Chain A:

- Molecule 1: Extracellular solute-binding protein family 1

Chain B:

4　Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	73.36Å　　93.08Å　　103.64Å 90.00°　　90.00°　　90.00°	Depositor
Resolution (Å)	26.62　–　1.61 26.62　–　1.61	Depositor EDS
% Data completeness (in resolution range)	95.1 (26.62-1.61) 95.1 (26.62-1.61)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$<I/\sigma(I)>$ [1]	6.44 (at 1.61Å)	Xtriage
Refinement program	PHENIX	Depositor
R, R_{free}	0.132　,　0.168 0.133　,　0.170	Depositor DCC
R_{free} test set	4332 reflections (4.91%)	wwPDB-VP
Wilson B-factor (Å^2)	12.7	Xtriage
Anisotropy	0.180	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.37 , 48.4	EDS
L-test for twinning[2]	$<|L|> = 0.50, <L^2> = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	13645	wwPDB-VP
Average B, all atoms (Å^2)	18.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 22.10 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 6.1135e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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[1]Intensities estimated from amplitudes.

[2]Theoretical values of $<|L|>$, $<L^2>$ 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: T6T, EDO, 1PE

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	0.50	0/3233	0.61	0/4384
1	B	0.48	0/3249	0.61	1/4406 (0.0%)
All	All	0.49	0/6482	0.61	1/8790 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	22	LEU	CA-CB-CG	5.24	127.34	115.30

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	3151	3110	3107	5	0
1	B	3145	3100	3082	9	0
2	A	12	12	0	0	0
2	B	12	12	0	0	0
3	B	4	6	6	0	0
4	B	16	22	22	0	0
5	A	554	0	0	1	2
5	B	489	0	0	3	3

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	7383	6262	6217	13	3

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 1.

All (13) 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:386:ARG:NH2	5:A:603:HOH:O	2.33	0.61
1:B:175:ARG:HG3	1:B:255:ARG:HE	1.72	0.54
1:B:141:ASN:OD1	5:B:601:HOH:O	2.19	0.52
1:B:55:GLN:NE2	5:B:602:HOH:O	2.33	0.52
1:B:20:LYS:HE2	1:B:311:ASP:OD2	2.18	0.44
1:A:136:ARG:CZ	1:A:191:LEU:HD13	2.49	0.43
1:B:331:GLU:HG3	1:B:332:LYS:HD2	1.99	0.43
1:A:138:LEU:O	1:A:282:VAL:HA	2.19	0.42
1:B:136:ARG:CZ	1:B:191:LEU:HD13	2.50	0.41
1:B:231:LYS:NZ	5:B:623:HOH:O	2.53	0.41
1:A:362:PRO:HG3	1:B:241[A]:GLN:CD	2.41	0.41
1:A:361:PHE:HB3	1:A:362:PRO:HD3	2.03	0.41
1:B:26:ILE:HD13	1:B:37:TRP:CD2	2.57	0.40

All (3) 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)
5:A:861:HOH:O	5:B:674:HOH:O[4_567]	2.12	0.08
5:B:976:HOH:O	5:B:988:HOH:O[2_564]	2.15	0.05
5:A:932:HOH:O	5:B:990:HOH:O[3_646]	2.19	0.01

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	394/415 (95%)	389 (99%)	5 (1%)	0	100	100
1	B	395/415 (95%)	388 (98%)	7 (2%)	0	100	100
All	All	789/830 (95%)	777 (98%)	12 (2%)	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	331/336 (98%)	329 (99%)	2 (1%)	86	76
1	B	333/336 (99%)	328 (98%)	5 (2%)	65	43
All	All	664/672 (99%)	657 (99%)	7 (1%)	73	56

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	132	TYR
1	A	355	GLN
1	B	22	LEU
1	B	132	TYR
1	B	173	LYS
1	B	175	ARG
1	B	211	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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)

4 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	#$|Z| > 2$
3	EDO	B	502	-	3,3,3	0.41	0	2,2,2	0.38	0
4	1PE	B	503	-	15,15,15	0.87	0	14,14,14	0.57	0
2	T6T	B	501	-	12,12,12	1.44	1 (8%)	18,18,18	1.02	2 (11%)
2	T6T	A	501	-	12,12,12	1.58	1 (8%)	18,18,18	1.03	1 (5%)

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
3	EDO	B	502	-	-	1/1/1/1	-
4	1PE	B	503	-	-	6/13/13/13	-
2	T6T	B	501	-	-	0/3/23/23	0/1/1/1
2	T6T	A	501	-	-	0/3/23/23	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	501	T6T	C2-C3	-4.65	1.49	1.53
2	B	501	T6T	C2-C3	-3.95	1.50	1.53

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	501	T6T	C5-C4-C3	-2.61	107.56	110.48
2	B	501	T6T	O6-C2-C3	2.50	112.26	109.76
2	A	501	T6T	C5-C4-C3	-2.18	108.04	110.48

There are no chirality outliers.

All (7) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	B	503	1PE	OH7-C16-C26-OH6
4	B	503	1PE	OH5-C14-C24-OH4
4	B	503	1PE	C14-C24-OH4-C13
3	B	502	EDO	O1-C1-C2-O2
4	B	503	1PE	OH4-C13-C23-OH3
4	B	503	1PE	C15-C25-OH5-C14
4	B	503	1PE	OH6-C15-C25-OH5

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, 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	382/415 (92%)	-0.70	2 (0%)	91	90	7, 12, 31, 60	0
1	B	381/415 (91%)	-0.65	3 (0%)	86	86	7, 14, 32, 62	0
All	All	763/830 (91%)	-0.68	5 (0%)	87	87	7, 13, 32, 62	0

All (5) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	19	SER	4.8
1	A	411	ALA	4.5
1	B	173	LYS	3.8
1	B	410	GLY	2.3
1	B	172	THR	2.0

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, 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(Å^2)	Q<0.9
4	1PE	B	503	16/16	0.78	0.14	27,41,52,58	0
3	EDO	B	502	4/4	0.83	0.15	15,30,37,44	0
2	T6T	B	501	12/12	0.99	0.06	7,8,9,9	0
2	T6T	A	501	12/12	0.99	0.05	5,8,10,10	0

6.5 Other polymers (i)

There are no such residues in this entry.