wwPDB X-ray Structure Validation Summary Report (i)

Dec 17, 2023 – 02:46 pm GMT

PDB ID	:	2XU9
Title	:	Crystal structure of Laccase from Thermus thermophilus HB27
Authors	:	Serrano-Posada, H.; Valderrama, B.; Rudino-Pinera, E.
Deposited on	:	2010-10-15
Resolution	:	1.50 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 (i) 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 (i)) were used in the production of this report:

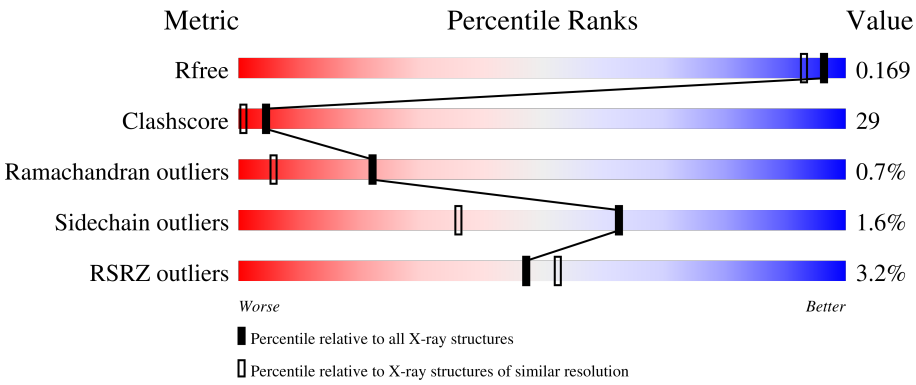
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.50 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	2936 (1.50-1.50)
Clashscore	141614	3144 (1.50-1.50)
Ramachandran outliers	138981	3066 (1.50-1.50)
Sidechain outliers	138945	3064 (1.50-1.50)
RSRZ outliers	127900	2884 (1.50-1.50)

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 <=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	439	3% 76% 23%

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	MPD	A	1475	-	-	X	-

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Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	MPD	A	1476	-	-	X	-
3	MPD	A	1478	-	-	X	-
3	MPD	A	1480	-	-	X	-
4	MRD	A	1472	-	-	X	-
4	MRD	A	1481	-	-	X	X
5	OH	A	1483	-	-	-	X

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 4942 atoms, of which 1 is hydrogen 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 LACCASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	439	4259	2747	763	731	18	0	84	0

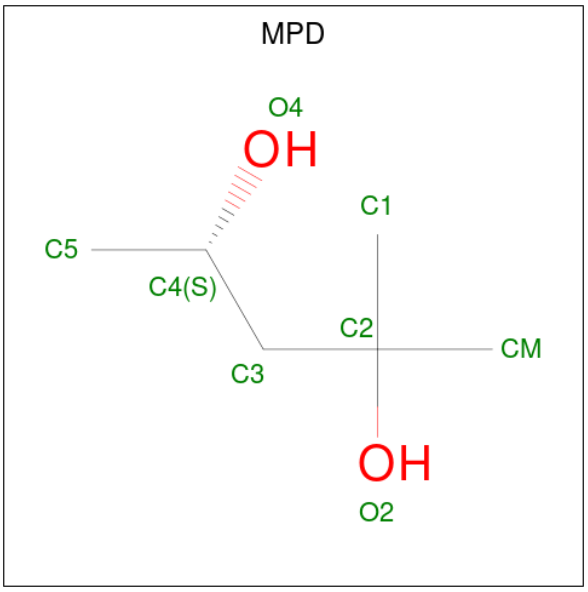
There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	53	ILE	LEU	engineered mutation	UNP Q72HW2

- Molecule 2 is COPPER (II) ION (three-letter code: CU) (formula: Cu).

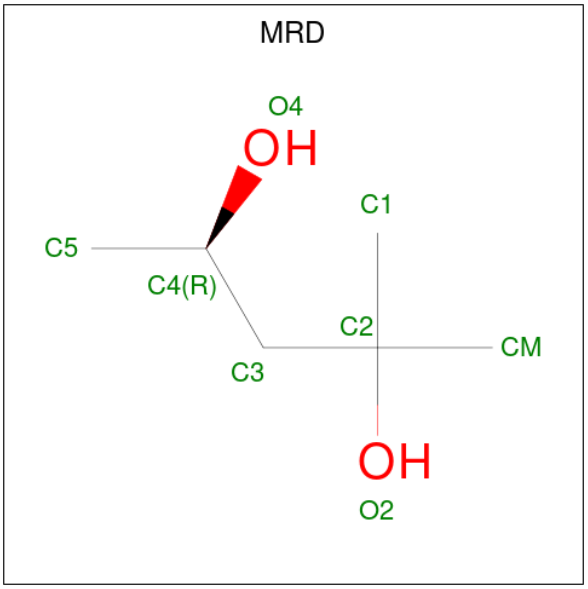
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Cu		
2	A	4	4	4	0	0

- Molecule 3 is (4S)-2-METHYL-2,4-PENTANEDIOL (three-letter code: MPD) (formula: $C_6H_{14}O_2$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	O		0	0
			8	6	2			
3	A	1	Total	C	O		0	0
			8	6	2			
3	A	1	Total	C	O		0	0
			8	6	2			
3	A	1	Total	C	O		0	0
			8	6	2			
3	A	1	Total	C	O		0	0
			8	6	2			
3	A	1	Total	C	O		0	0
			8	6	2			

- Molecule 4 is (4R)-2-METHYLPENTANE-2,4-DIOL (three-letter code: MRD) (formula: $C_6H_{14}O_2$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	O		0	0
			8	6	2			
4	A	1	Total	C	O		0	0
			8	6	2			
4	A	1	Total	C	O		0	0
			8	6	2			
4	A	1	Total	C	O		0	0
			8	6	2			
4	A	1	Total	C	O		0	0
			8	6	2			

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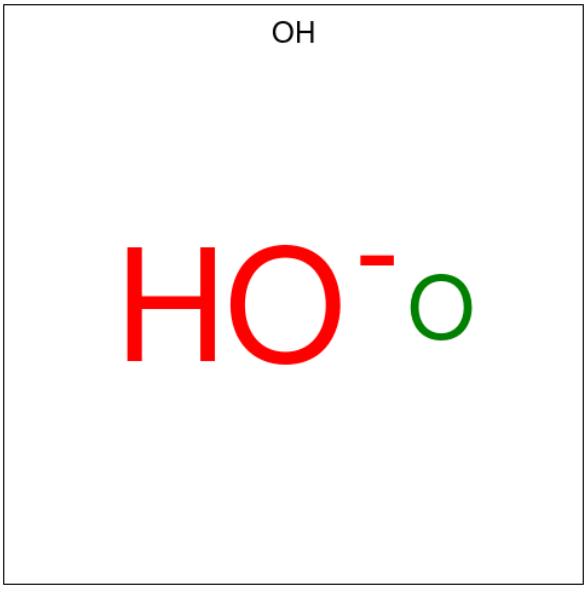
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
4	A	1	8	6	2	0	0
			Total	C	O		
4	A	1	8	6	2	0	0
			Total	C	O		
4	A	1	8	6	2	0	0
			Total	C	O		
4	A	1	8	6	2	0	0
			Total	C	O		
4	A	1	8	6	2	0	0

- Molecule 5 is HYDROXIDE ION (three-letter code: OH) (formula: HO).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	H	O		
5	A	1	2	1	1	0	0

- Molecule 6 is water.

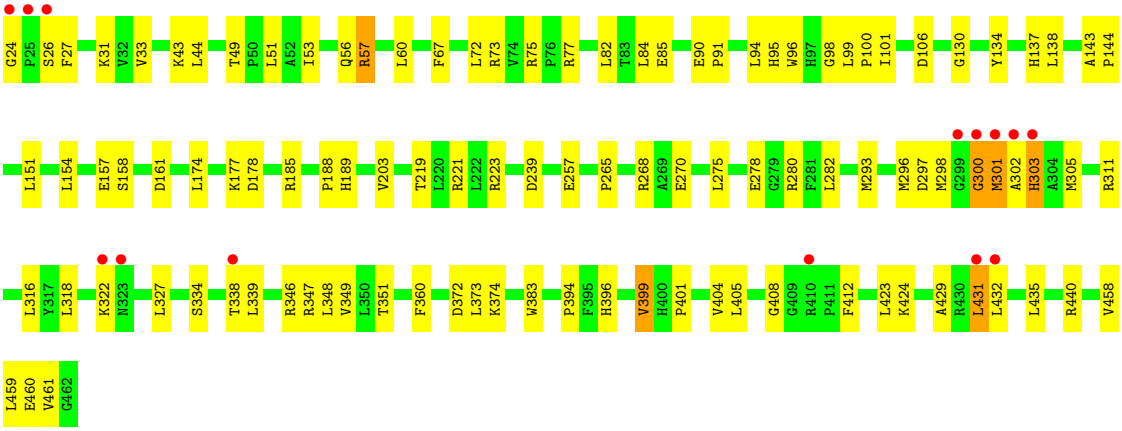
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
6	A	549	549	549	0	0

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: LACCASE

Chain A:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	93.58Å 110.34Å 96.32Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	22.82 – 1.50 22.82 – 1.50	Depositor EDS
% Data completeness (in resolution range)	99.1 (22.82-1.50) 99.1 (22.82-1.50)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.16 (at 1.50Å)	Xtriage
Refinement program	PHENIX (PHENIX.REFINE)	Depositor
R, R_{free}	0.153 , 0.178 0.147 , 0.169	Depositor DCC
R_{free} test set	3958 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å^2)	12.5	Xtriage
Anisotropy	0.015	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 56.3	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	4942	wwPDB-VP
Average B, all atoms (Å^2)	16.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.55% of the height of the origin peak. No significant pseudotranslation is detected.*

[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: MPD, OH, CU, MRD

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	0.40	0/4367	0.59	0/5946

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	A	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	300	GLY	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	4259	0	4395	198	0
2	A	4	0	0	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	48	0	83	42	0
4	A	80	0	137	35	0
5	A	1	1	0	0	0
6	A	549	0	0	79	3
All	All	4941	1	4615	254	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 29.

The worst 5 of 254 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)
3:A:1475:MPD:H4	6:A:2275:HOH:O	1.32	1.25
3:A:1478:MPD:H11	3:A:1478:MPD:C5	1.60	1.25
4:A:1474:MRD:H1C1	4:A:1474:MRD:C5	1.70	1.21
3:A:1476:MPD:H11	6:A:2545:HOH:O	1.44	1.18
3:A:1475:MPD:C4	6:A:2275:HOH:O	1.86	1.17

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)
6:A:2125:HOH:O	6:A:2125:HOH:O[4_545]	2.06	0.14
6:A:2034:HOH:O	6:A:2223:HOH:O[8_445]	2.08	0.12
6:A:2429:HOH:O	6:A:2543:HOH:O[6_445]	2.16	0.04

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	537/439 (122%)	520 (97%)	13 (2%)	4 (1%)	22 6

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	301	MET
1	A	399	VAL
1	A	394[A]	PRO
1	A	394[B]	PRO

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	467/367 (127%)	458 (98%)	9 (2%)	57 27

5 of 9 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	431[B]	LEU
1	A	431[C]	LEU
1	A	268	ARG
1	A	303	HIS
1	A	412	PHE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	36	GLN
1	A	229	ASN
1	A	307	GLN
1	A	388	GLN

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)

Of 21 ligands modelled in this entry, 4 are monoatomic and 1 is modelled with single atom - leaving 16 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	$\#\|Z\| > 2$
3	MPD	A	1466	-	7,7,7	0.58	0	9,10,10	0.35	0
4	MRD	A	1469	-	7,7,7	0.55	0	9,10,10	0.99	0
3	MPD	A	1477	-	7,7,7	0.66	0	9,10,10	1.47	3 (33%)
4	MRD	A	1481	-	7,7,7	2.44	3 (42%)	9,10,10	2.25	3 (33%)
4	MRD	A	1467	-	7,7,7	0.87	0	9,10,10	0.49	0
4	MRD	A	1468	-	7,7,7	1.03	0	9,10,10	1.01	0
4	MRD	A	1472	-	7,7,7	0.81	0	9,10,10	1.32	2 (22%)
4	MRD	A	1473	-	7,7,7	0.89	0	9,10,10	1.51	2 (22%)
3	MPD	A	1476	-	7,7,7	0.54	0	9,10,10	0.91	0
4	MRD	A	1470	-	7,7,7	0.59	0	9,10,10	1.15	1 (11%)
4	MRD	A	1474	-	7,7,7	0.91	0	9,10,10	0.78	0
3	MPD	A	1480	-	7,7,7	0.39	0	9,10,10	1.04	0
4	MRD	A	1471	-	7,7,7	0.64	0	9,10,10	1.06	0
3	MPD	A	1475	-	7,7,7	1.58	1 (14%)	9,10,10	2.91	2 (22%)
3	MPD	A	1478	-	7,7,7	0.73	0	9,10,10	0.87	0
4	MRD	A	1479	-	7,7,7	0.70	0	9,10,10	1.00	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
3	MPD	A	1466	-	-	0/5/5/5	-
4	MRD	A	1469	-	-	4/5/5/5	-
3	MPD	A	1477	-	-	5/5/5/5	-
4	MRD	A	1481	-	-	1/5/5/5	-
4	MRD	A	1467	-	-	0/5/5/5	-
4	MRD	A	1468	-	-	0/5/5/5	-
4	MRD	A	1472	-	-	5/5/5/5	-
4	MRD	A	1473	-	-	0/5/5/5	-
3	MPD	A	1476	-	-	1/5/5/5	-
4	MRD	A	1470	-	-	2/5/5/5	-
4	MRD	A	1474	-	-	1/5/5/5	-
3	MPD	A	1480	-	-	2/5/5/5	-
4	MRD	A	1471	-	-	0/5/5/5	-
3	MPD	A	1475	-	-	3/5/5/5	-
3	MPD	A	1478	-	-	1/5/5/5	-
4	MRD	A	1479	-	-	3/5/5/5	-

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1481	MRD	C5-C4	-5.31	1.28	1.51
3	A	1475	MPD	O2-C2	-3.44	1.36	1.44
4	A	1481	MRD	CM-C2	-2.49	1.44	1.52
4	A	1481	MRD	O4-C4	-2.09	1.34	1.43

The worst 5 of 13 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	A	1475	MPD	C5-C4-C3	-5.88	83.96	111.69
3	A	1475	MPD	O4-C4-C5	-5.26	86.61	109.38
4	A	1481	MRD	O4-C4-C5	4.17	127.42	109.38
4	A	1481	MRD	O2-C2-C1	3.76	120.14	108.08
4	A	1473	MRD	O2-C2-C1	-3.52	96.79	108.08

There are no chirality outliers.

5 of 28 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	1475	MPD	C2-C3-C4-O4

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Mol	Chain	Res	Type	Atoms
3	A	1478	MPD	C2-C3-C4-C5
4	A	1469	MRD	O2-C2-C3-C4
4	A	1469	MRD	C2-C3-C4-C5
4	A	1470	MRD	C2-C3-C4-O4

There are no ring outliers.

11 monomers are involved in 72 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	1469	MRD	3	0
3	A	1477	MPD	5	0
4	A	1481	MRD	12	0
4	A	1472	MRD	8	0
4	A	1473	MRD	3	0
3	A	1476	MPD	9	0
4	A	1470	MRD	4	0
4	A	1474	MRD	5	0
3	A	1480	MPD	10	0
3	A	1475	MPD	9	0
3	A	1478	MPD	9	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	439/439 (100%)	-0.10	14 (3%) 47 52	5, 12, 26, 62	1 (0%)

The worst 5 of 14 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	301	MET	8.2
1	A	303	HIS	3.8
1	A	302	ALA	3.3
1	A	26[A]	SER	3.0
1	A	338	THR	2.7

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
5	OH	A	1483	1/1	0.57	0.60	19,19,19,23	2
3	MPD	A	1477	8/8	0.58	0.25	30,42,45,46	8

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	MPD	A	1475	8/8	0.64	0.33	35,41,51,52	0
4	MRD	A	1481	8/8	0.66	0.41	19,24,36,43	8
3	MPD	A	1480	8/8	0.66	0.25	33,38,43,46	8
3	MPD	A	1478	8/8	0.79	0.20	32,45,70,73	0
4	MRD	A	1479	8/8	0.80	0.18	37,39,49,54	8
4	MRD	A	1474	8/8	0.82	0.15	19,20,32,33	8
3	MPD	A	1476	8/8	0.87	0.17	23,26,36,45	8
4	MRD	A	1472	8/8	0.87	0.22	16,27,46,51	8
4	MRD	A	1469	8/8	0.89	0.17	25,34,37,40	0
4	MRD	A	1473	8/8	0.89	0.16	26,40,42,45	0
2	CU	A	1482	1/1	0.90	0.21	19,19,19,19	1
4	MRD	A	1470	8/8	0.90	0.20	17,32,51,63	0
3	MPD	A	1466	8/8	0.92	0.10	10,12,16,16	0
4	MRD	A	1467	8/8	0.94	0.07	14,19,23,24	0
4	MRD	A	1468	8/8	0.94	0.12	24,29,39,39	0
4	MRD	A	1471	8/8	0.94	0.09	18,27,37,37	0
2	CU	A	1464	1/1	0.99	0.05	13,13,13,13	1
2	CU	A	1463	1/1	1.00	0.05	7,7,7,7	1
2	CU	A	1465	1/1	1.00	0.04	10,10,10,10	0

6.5 Other polymers (i)

There are no such residues in this entry.