



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 02:50 PM UTC

PDB ID : 3A5R / pdb_00003a5r
Title : Benzalacetone synthase from *Rheum palmatum* complexed with 4-coumaroyl-primed monoketide intermediate
Authors : Morita, H.; Kato, R.; Abe, I.; Sugio, S.; Kohno, T.
Deposited on : 2009-08-10
Resolution : 1.60 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

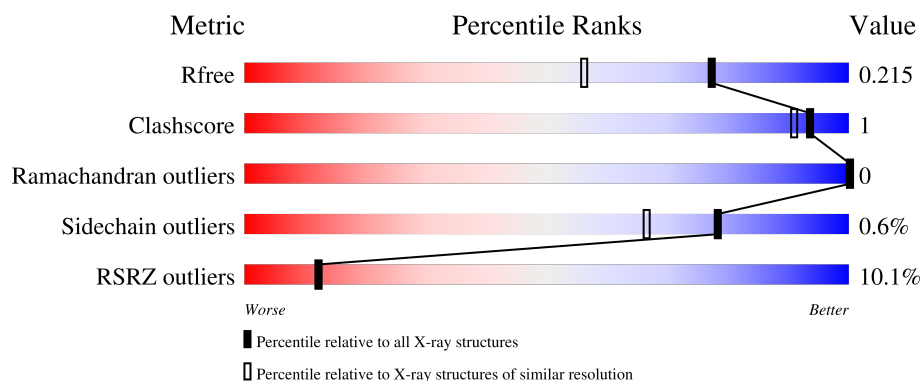
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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	4673 (1.60-1.60)
Clashscore	190562	4931 (1.60-1.60)
Ramachandran outliers	187476	4831 (1.60-1.60)
Sidechain outliers	187428	4830 (1.60-1.60)
RSRZ outliers	180081	4672 (1.60-1.60)

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 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	387	16% 90% 6% . .
1	B	387	3% 90% 6% . .

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 6372 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.

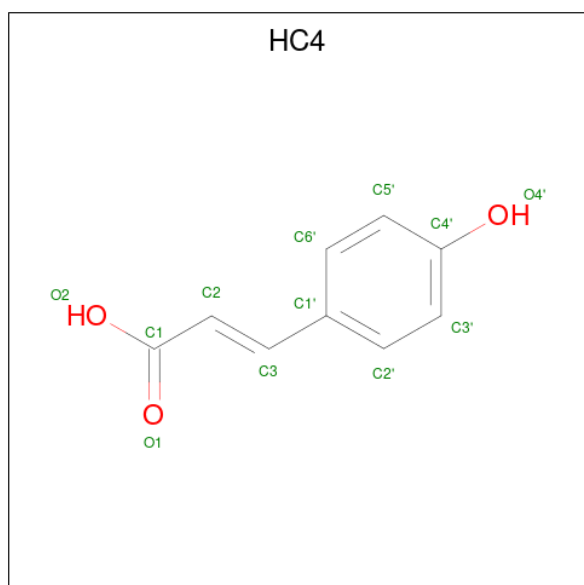
- Molecule 1 is a protein called Benzalacetone synthase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	376	Total	C	N	O	S	0	0	0
			2902	1854	491	540	17			
1	B	375	Total	C	N	O	S	0	0	0
			2894	1848	490	539	17			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	GLY	-	expression tag	UNP Q94FV7
A	-1	PRO	-	expression tag	UNP Q94FV7
A	0	GLY	-	expression tag	UNP Q94FV7
B	-2	GLY	-	expression tag	UNP Q94FV7
B	-1	PRO	-	expression tag	UNP Q94FV7
B	0	GLY	-	expression tag	UNP Q94FV7

- Molecule 2 is 4'-HYDROXYCINNAMIC ACID (CCD ID: HC4) (formula: C₉H₈O₃).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			11	9	2		
2	B	1	Total	C	O	0	0
			11	9	2		

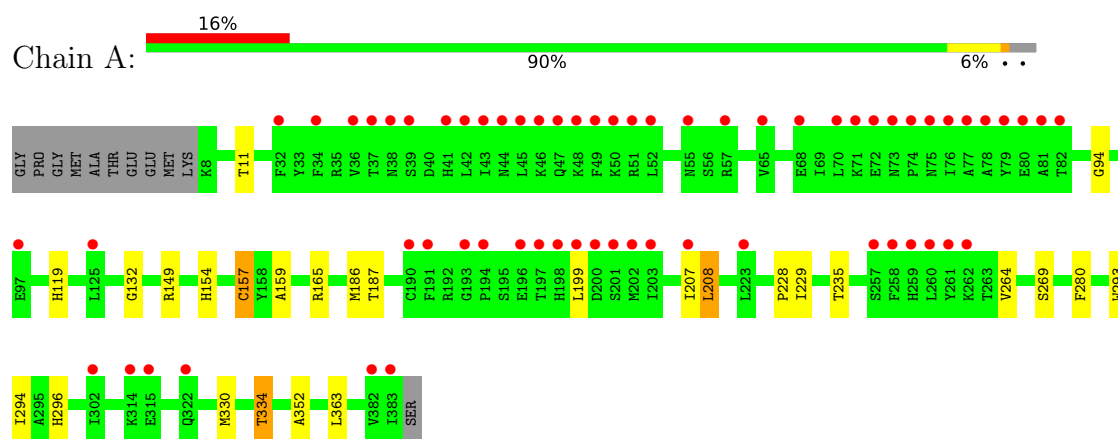
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	243	Total	O	0	0
			243	243		
3	B	311	Total	O	0	0
			311	311		

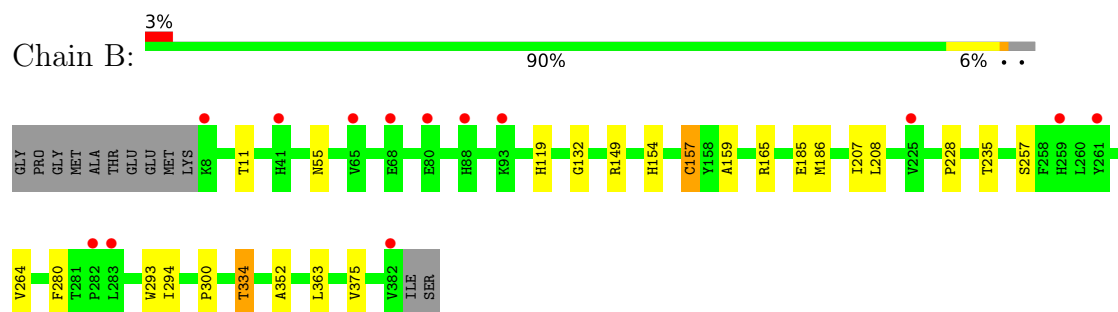
3 Residue-property plots [i](#)

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: Benzalacetone synthase



- Molecule 1: Benzalacetone synthase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	54.62Å 89.85Å 81.10Å 90.00° 100.45° 90.00°	Depositor
Resolution (Å)	30.00 – 1.60 30.00 – 1.60	Depositor EDS
% Data completeness (in resolution range)	99.5 (30.00-1.60) 99.6 (30.00-1.60)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.07	Depositor
$\langle I/\sigma(I) \rangle$ ¹	8.86 (at 1.60Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.195 , 0.215 0.197 , 0.215	Depositor DCC
R_{free} test set	5108 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å ²)	9.7	Xtriage
Anisotropy	0.406	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 25.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	6372	wwPDB-VP
Average B, all atoms (Å ²)	13.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.34% 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 ⓘ

5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: HC4

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	0.64	1/2961 (0.0%)	1.04	13/4014 (0.3%)
1	B	0.63	1/2953 (0.0%)	1.04	12/4003 (0.3%)
All	All	0.63	2/5914 (0.0%)	1.04	25/8017 (0.3%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	264	VAL	CA-CB	9.30	1.58	1.54
1	B	264	VAL	CA-CB	7.66	1.57	1.54

All (25) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	157	CYS	N-CA-C	9.22	123.94	112.87
1	A	157	CYS	N-CA-C	9.08	123.46	112.38
1	B	207	ILE	N-CA-C	7.77	120.73	112.96
1	B	280	PHE	N-CA-C	6.95	121.93	113.38
1	B	159	ALA	N-CA-C	6.55	120.86	112.34
1	A	159	ALA	N-CA-C	6.53	120.83	112.34
1	A	207	ILE	N-CA-C	6.38	117.29	111.81
1	A	280	PHE	N-CA-C	6.35	121.19	113.38
1	A	154	HIS	N-CA-C	6.23	120.15	111.74
1	B	154	HIS	N-CA-C	6.21	120.12	111.74
1	A	208	LEU	N-CA-C	5.88	118.79	109.96
1	A	132	GLY	N-CA-C	5.86	121.63	112.31
1	B	149	ARG	N-CA-C	5.81	119.52	110.17
1	B	334	THR	N-CA-C	5.72	117.97	111.11
1	A	334	THR	N-CA-C	5.63	117.87	111.11
1	A	149	ARG	N-CA-C	5.57	119.14	110.17
1	A	293	TRP	N-CA-C	5.56	118.02	109.07

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	229	ILE	N-CA-C	-5.50	107.28	111.62
1	B	132	GLY	N-CA-C	5.49	121.03	112.31
1	A	269	SER	N-CA-C	5.31	117.07	111.28
1	B	352	ALA	N-CA-C	5.27	117.77	111.71
1	B	293	TRP	N-CA-C	5.25	117.47	108.90
1	B	208	LEU	N-CA-C	5.20	118.03	109.76
1	A	352	ALA	N-CA-C	5.18	118.70	112.38
1	B	185	GLU	N-CA-C	5.03	116.72	108.52

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts ⓘ

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	2902	0	2941	8	0
1	B	2894	0	2930	8	0
2	A	11	0	7	0	0
2	B	11	0	7	2	0
3	A	243	0	0	1	0
3	B	311	0	0	1	0
All	All	6372	0	5885	16	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 1.

All (16) 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:187:THR:HG21	1:A:208:LEU:HB3	1.92	0.51
1:A:119:HIS:HE1	3:B:522:HOH:O	1.95	0.49
1:B:55:ASN:O	1:B:300:PRO:HG3	2.13	0.48
3:A:531:HOH:O	1:B:119:HIS:HE1	1.97	0.46
1:A:94:GLY:HA3	1:A:186:MET:SD	2.55	0.46
1:A:165:ARG:HA	1:A:235:THR:HG21	1.96	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:11:THR:HG21	1:B:228:PRO:HB3	1.97	0.46
1:B:165:ARG:HA	1:B:235:THR:HG21	1.98	0.45
1:B:157:CYS:H	2:B:400:HC4:C1	2.32	0.42
1:A:11:THR:HG21	1:A:228:PRO:HB3	2.01	0.42
1:A:157:CYS:HB3	1:A:296:HIS:NE2	2.35	0.42
1:B:257:SER:O	2:B:400:HC4:H3'	2.20	0.41
1:A:330:MET:HE3	1:A:330:MET:HB2	1.98	0.41
1:A:294:ILE:O	1:A:363:LEU:HA	2.21	0.41
1:B:363:LEU:HB3	1:B:375:VAL:HB	2.03	0.40
1:B:294:ILE:O	1:B:363:LEU:HA	2.22	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	374/387 (97%)	365 (98%)	9 (2%)	0	100	100
1	B	373/387 (96%)	361 (97%)	12 (3%)	0	100	100
All	All	747/774 (96%)	726 (97%)	21 (3%)	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	317/325 (98%)	315 (99%)	2 (1%)	78	66
1	B	316/325 (97%)	314 (99%)	2 (1%)	78	66
All	All	633/650 (97%)	629 (99%)	4 (1%)	78	66

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	199	LEU
1	A	334	THR
1	B	186	MET
1	B	334	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (15) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	41	HIS
1	A	47	GLN
1	A	55	ASN
1	A	64	HIS
1	A	91	GLN
1	A	119	HIS
1	A	136	GLN
1	A	270	ASN
1	A	305	GLN
1	B	41	HIS
1	B	119	HIS
1	B	198	HIS
1	B	270	ASN
1	B	305	GLN
1	B	349	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 [i](#)

There are no oligosaccharides 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	HC4	B	400	1	11,11,12	3.65	3 (27%)	13,13,15	2.13	2 (15%)
2	HC4	A	400	1	11,11,12	4.01	5 (45%)	13,13,15	1.92	2 (15%)

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	HC4	B	400	1	-	1/4/4/5	0/1/1/1
2	HC4	A	400	1	-	1/4/4/5	0/1/1/1

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	400	HC4	C2-C3	11.82	1.56	1.34
2	B	400	HC4	C2-C3	11.08	1.54	1.34
2	A	400	HC4	C2-C1	3.32	1.53	1.44
2	B	400	HC4	C1'-C3	-2.91	1.39	1.47
2	A	400	HC4	C1'-C3	-2.81	1.39	1.47
2	A	400	HC4	C3'-C2'	2.61	1.43	1.38
2	B	400	HC4	C2-C1	2.60	1.51	1.44
2	A	400	HC4	C6'-C5'	2.48	1.42	1.38

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	400	HC4	C1'-C3-C2	-6.25	116.28	127.11
2	A	400	HC4	C1'-C3-C2	-5.77	117.12	127.11
2	B	400	HC4	C3-C2-C1	-4.03	109.58	121.11
2	A	400	HC4	C3-C2-C1	-3.18	112.02	121.11

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	400	HC4	O1-C1-C2-C3
2	B	400	HC4	O1-C1-C2-C3

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	400	HC4	2	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

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	376/387 (97%)	0.62	63 (16%) 4 3	5, 12, 33, 46	0
1	B	375/387 (96%)	0.11	13 (3%) 47 49	5, 10, 21, 26	0
All	All	751/774 (97%)	0.37	76 (10%) 12 12	5, 11, 28, 46	0

All (76) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	199	LEU	9.0
1	A	200	ASP	6.8
1	A	201	SER	5.6
1	A	383	ILE	4.9
1	A	79	TYR	4.4
1	A	198	HIS	4.3
1	B	382	VAL	3.9
1	A	197	THR	3.8
1	A	43	ILE	3.8
1	A	47	GLN	3.8
1	A	51	ARG	3.7
1	A	74	PRO	3.6
1	A	191	PHE	3.6
1	A	44	ASN	3.5
1	A	203	ILE	3.5
1	A	80	GLU	3.5
1	A	207	ILE	3.5
1	A	41	HIS	3.5
1	A	81	ALA	3.4
1	A	70	LEU	3.3
1	A	37	THR	3.3
1	A	42	LEU	3.3
1	A	77	ALA	3.2
1	A	71	LYS	3.2

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Mol	Chain	Res	Type	RSRZ
1	A	45	LEU	3.2
1	A	315	GLU	3.1
1	A	68	GLU	3.0
1	A	39	SER	3.0
1	A	50	LYS	3.0
1	A	202	MET	2.9
1	A	46	LYS	2.9
1	B	80	GLU	2.9
1	A	259	HIS	2.8
1	A	78	ALA	2.8
1	A	55	ASN	2.8
1	A	48	LYS	2.8
1	A	76	ILE	2.8
1	A	261	TYR	2.7
1	B	68	GLU	2.7
1	A	75	ASN	2.7
1	B	259	HIS	2.6
1	A	72	GLU	2.6
1	A	97	GLU	2.6
1	A	260	LEU	2.6
1	A	382	VAL	2.6
1	A	57	ARG	2.6
1	A	193	GLY	2.5
1	A	194	PRO	2.5
1	A	34	PHE	2.5
1	A	52	LEU	2.5
1	B	261	TYR	2.5
1	A	82	THR	2.5
1	A	257	SER	2.4
1	B	225	VAL	2.4
1	A	314	LYS	2.4
1	B	41	HIS	2.4
1	A	38	ASN	2.4
1	A	125	LEU	2.4
1	B	88	HIS	2.3
1	B	282	PRO	2.3
1	B	283	LEU	2.3
1	A	32	PHE	2.3
1	A	302	ILE	2.3
1	A	196	GLU	2.2
1	A	223	LEU	2.2
1	A	73	ASN	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	36	VAL	2.1
1	B	65	VAL	2.1
1	A	262	LYS	2.1
1	A	190	CYS	2.1
1	B	93	LYS	2.1
1	A	65	VAL	2.1
1	A	322	GLN	2.1
1	B	8	LYS	2.0
1	A	49	PHE	2.0
1	A	258	PHE	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 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(Å ²)	Q<0.9
2	HC4	B	400	11/12	0.74	0.15	17,20,22,23	0
2	HC4	A	400	11/12	0.75	0.14	18,21,23,25	0

6.5 Other polymers [i](#)

There are no such residues in this entry.