



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 10:56 PM UTC

PDB ID : 6AT3 / pdb_00006at3
Title : E. coli phosphoenolpyruvate carboxykinase Y207F mutant bound to thiosulfate and oxaloacetate
Authors : Tang, H.Y.H.; Shin, D.S.; Tainer, J.A.
Deposited on : 2017-08-27
Resolution : 1.46 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

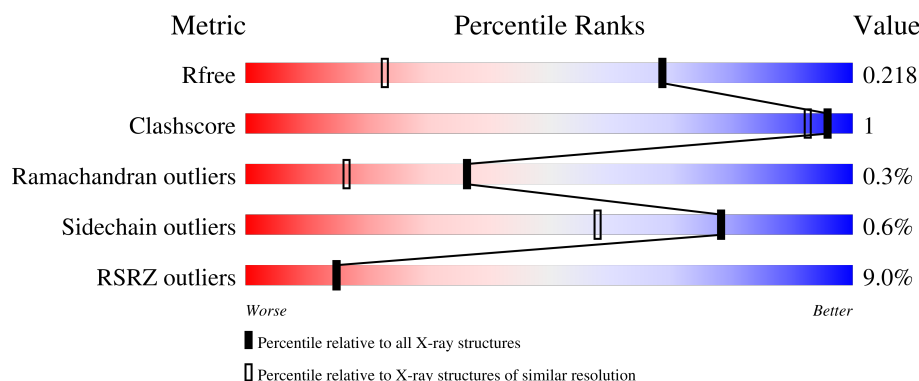
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.46 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	1756 (1.46-1.46)
Clashscore	190562	1795 (1.46-1.46)
Ramachandran outliers	187476	1776 (1.46-1.46)
Sidechain outliers	187428	1776 (1.46-1.46)
RSRZ outliers	180081	1756 (1.46-1.46)

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	546	6% 95% ..
1	B	546	11% 94% ..

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
2	OAA	A	601	-	X	-	-

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 16947 atoms, of which 7863 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.

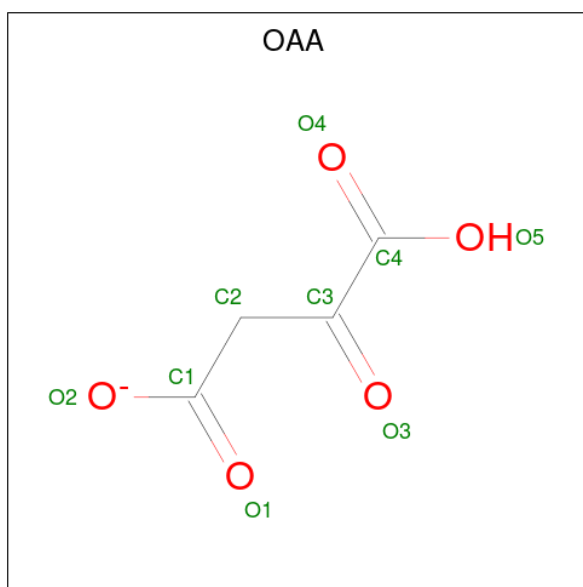
- Molecule 1 is a protein called Phosphoenolpyruvate carboxykinase (ATP).

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	535	Total	C	H	N	O	S	0	0	0
			8059	2613	3963	689	779	15			
1	B	534	Total	C	H	N	O	S	0	0	0
			7963	2590	3898	684	776	15			

There are 14 discrepancies between the modelled and reference sequences:

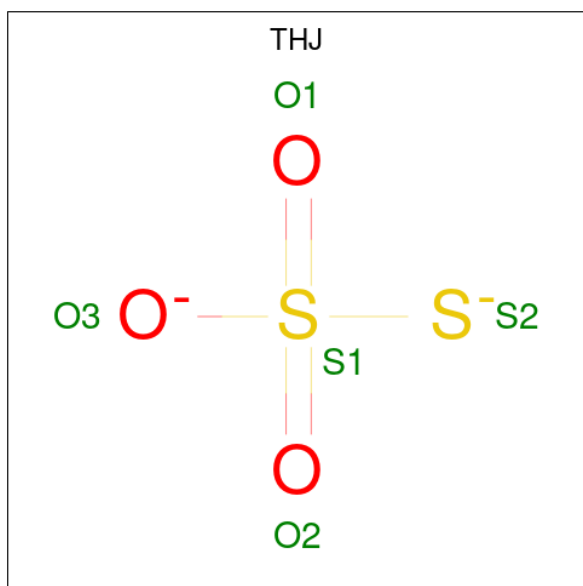
Chain	Residue	Modelled	Actual	Comment	Reference
A	207	PHE	TYR	engineered mutation	UNP P22259
A	541	HIS	-	expression tag	UNP P22259
A	542	HIS	-	expression tag	UNP P22259
A	543	HIS	-	expression tag	UNP P22259
A	544	HIS	-	expression tag	UNP P22259
A	545	HIS	-	expression tag	UNP P22259
A	546	HIS	-	expression tag	UNP P22259
B	207	PHE	TYR	engineered mutation	UNP P22259
B	541	HIS	-	expression tag	UNP P22259
B	542	HIS	-	expression tag	UNP P22259
B	543	HIS	-	expression tag	UNP P22259
B	544	HIS	-	expression tag	UNP P22259
B	545	HIS	-	expression tag	UNP P22259
B	546	HIS	-	expression tag	UNP P22259

- Molecule 2 is OXALOACETATE ION (CCD ID: OAA) (formula: $C_4H_3O_5$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	H	O	0	0
			11	4	2	5		

- Molecule 3 is THIOSULFATE (CCD ID: THJ) (formula: O_3S_2).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	O	S	0	0
			5	3	2		
3	B	1	Total	O	S	0	0
			5	3	2		
3	B	1	Total	O	S	0	0
			5	3	2		

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	B	1	Total	O	S	0	0
			5	3	2		

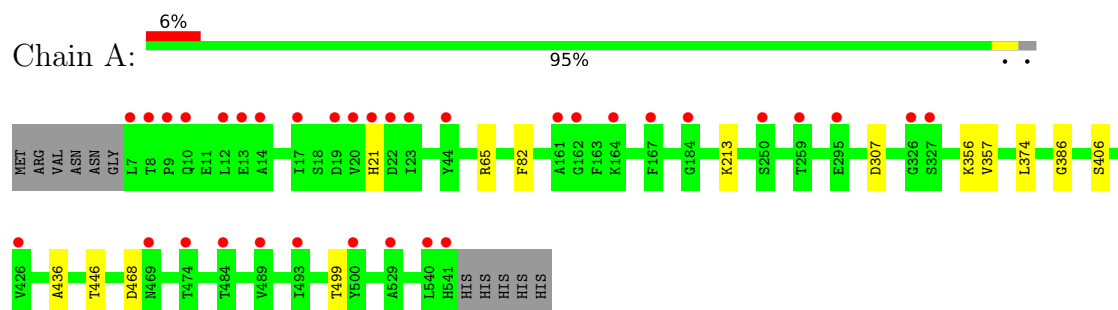
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	454	Total	O	0	0
			454	454		
4	B	440	Total	O	0	0
			440	440		

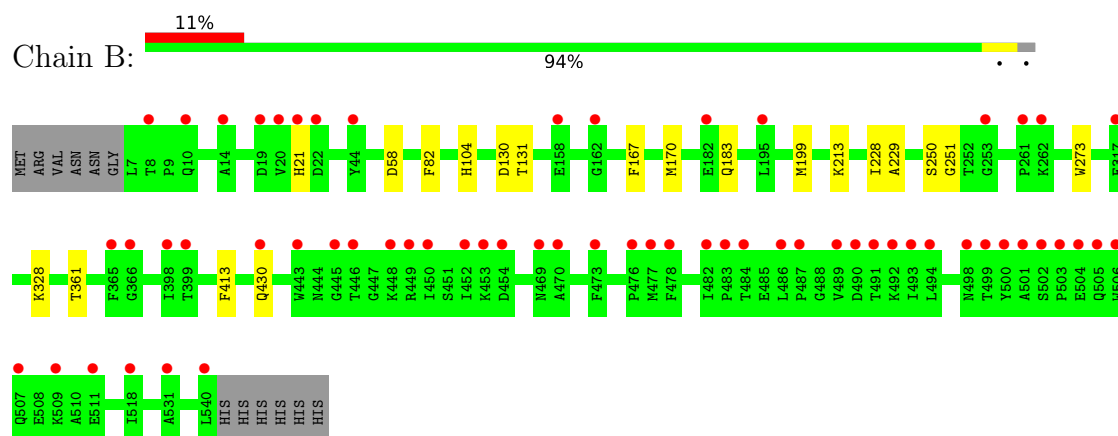
3 Residue-property plots [i](#)

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: Phosphoenolpyruvate carboxykinase (ATP)



- Molecule 1: Phosphoenolpyruvate carboxykinase (ATP)



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	94.67Å 105.86Å 120.49Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.34 – 1.46 47.34 – 1.46	Depositor EDS
% Data completeness (in resolution range)	98.3 (47.34-1.46) 88.0 (47.34-1.46)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	0.23 (at 1.46Å)	Xtriage
Refinement program	PHENIX (1.11.1 _2575: ???)	Depositor
R, R_{free}	0.199 , 0.219 0.199 , 0.218	Depositor DCC
R_{free} test set	1992 reflections (0.94%)	wwPDB-VP
Wilson B-factor (Å ²)	17.4	Xtriage
Anisotropy	0.548	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.43 , 39.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.28$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	16947	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 3.09% 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: OAA, THJ

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	0.34	0/4193	0.53	0/5704
1	B	0.35	0/4163	0.53	0/5672
All	All	0.34	0/8356	0.53	0/11376

There are no bond length outliers.

There are no bond angle outliers.

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	4096	3963	3958	7	0
1	B	4065	3898	3892	10	0
2	A	9	2	2	3	0
3	A	5	0	0	0	0
3	B	15	0	0	2	0
4	A	454	0	0	0	0
4	B	440	0	0	1	0
All	All	9084	7863	7852	17	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 (17) 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:356:LYS:NZ	1:A:468:ASP:OD2	2.21	0.73
1:B:250:SER:OG	3:B:602:THJ:S2	2.49	0.70
1:B:170:MET:HE2	1:B:199:MET:SD	2.38	0.64
1:A:65:ARG:HE	2:A:601:OAA:H22	1.65	0.61
1:A:357:VAL:O	1:A:436:ALA:HA	2.17	0.45
1:B:229:ALA:HB3	1:B:273:TRP:HB3	1.99	0.44
1:B:58:ASP:OD2	1:B:328:LYS:NZ	2.33	0.44
1:B:104:HIS:CD2	1:B:183:GLN:HE22	2.37	0.43
1:B:131:THR:HG21	1:B:228:ILE:HD13	1.99	0.43
1:A:65:ARG:NE	2:A:601:OAA:H22	2.32	0.43
1:B:251:GLY:N	3:B:603:THJ:S2	2.73	0.43
1:B:361:THR:HG23	1:B:361:THR:O	2.19	0.42
1:B:130:ASP:HB3	4:B:1083:HOH:O	2.20	0.42
1:A:446:THR:HG23	1:A:499:THR:HB	2.02	0.42
1:A:386:GLY:HA3	1:A:406:SER:O	2.20	0.41
1:B:213:LYS:HE2	1:B:413:PHE:CZ	2.55	0.41
1:A:213:LYS:HE3	2:A:601:OAA:C4	2.50	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	533/546 (98%)	519 (97%)	12 (2%)	2 (0%)	30	11
1	B	532/546 (97%)	519 (98%)	12 (2%)	1 (0%)	43	21
All	All	1065/1092 (98%)	1038 (98%)	24 (2%)	3 (0%)	36	16

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	21	HIS
1	B	21	HIS
1	A	307	ASP

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	423/454 (93%)	421 (100%)	2 (0%)	81	64
1	B	418/454 (92%)	415 (99%)	3 (1%)	76	54
All	All	841/908 (93%)	836 (99%)	5 (1%)	78	58

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	82	PHE
1	A	374	LEU
1	B	82	PHE
1	B	167	PHE
1	B	430	GLN

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	112	GLN
1	B	177	ASN
1	B	183	GLN
1	B	420	GLN

5.3.3 RNA ⓘ

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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

5 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	THJ	B	602	-	3,4,4	1.74	1 (33%)	2,6,6	0.40	0
3	THJ	A	602	-	3,4,4	1.29	0	2,6,6	0.51	0
3	THJ	B	601	-	3,4,4	1.47	0	2,6,6	0.38	0
3	THJ	B	603	-	3,4,4	1.46	1 (33%)	2,6,6	0.97	0
2	OAA	A	601	-	8,8,8	4.70	4 (50%)	8,10,10	5.65	5 (62%)

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	OAA	A	601	-	-	4/8/8/8	-

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	601	OAA	C3-C4	-8.89	1.40	1.53
2	A	601	OAA	O4-C4	-6.11	1.07	1.22
2	A	601	OAA	O3-C3	-5.75	1.11	1.23
2	A	601	OAA	C2-C1	4.75	1.58	1.51

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	602	THJ	O1-S1	2.45	1.52	1.45
3	B	603	THJ	O2-S1	2.11	1.51	1.45

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	601	OAA	O4-C4-C3	-10.56	108.67	121.81
2	A	601	OAA	O3-C3-C4	-8.11	108.09	119.67
2	A	601	OAA	O5-C4-C3	6.20	130.78	113.59
2	A	601	OAA	O1-C1-C2	-4.60	109.02	122.11
2	A	601	OAA	O2-C1-C2	3.90	126.59	114.51

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	601	OAA	C2-C3-C4-O4
2	A	601	OAA	C2-C3-C4-O5
2	A	601	OAA	O3-C3-C4-O4
2	A	601	OAA	C1-C2-C3-O3

There are no ring outliers.

3 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	602	THJ	1	0
3	B	603	THJ	1	0
2	A	601	OAA	3	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	535/546 (97%)	0.61	34 (6%) 25 24	19, 29, 44, 60	0
1	B	534/546 (97%)	0.77	62 (11%) 9 9	19, 29, 50, 65	0
All	All	1069/1092 (97%)	0.69	96 (8%) 15 15	19, 29, 48, 65	0

All (96) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	8	THR	5.5
1	A	541	HIS	5.1
1	B	502	SER	4.7
1	B	501	ALA	4.6
1	A	21	HIS	4.6
1	B	500	TYR	4.5
1	A	7	LEU	4.4
1	B	505	GLN	3.5
1	B	504	GLU	3.5
1	B	10	GLN	3.4
1	B	452	ILE	3.3
1	A	14	ALA	3.3
1	A	12	LEU	3.2
1	A	259	THR	3.2
1	B	493	ILE	3.2
1	B	506	TRP	3.1
1	A	13	GLU	3.1
1	B	473	PHE	3.0
1	A	493	ILE	3.0
1	A	426	VAL	3.0
1	B	430	GLN	3.0
1	B	445	GLY	3.0
1	B	448	LYS	2.9
1	B	20	VAL	2.8

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Mol	Chain	Res	Type	RSRZ
1	B	365	PHE	2.8
1	A	326	GLY	2.8
1	B	489	VAL	2.8
1	B	483	PRO	2.8
1	A	19	ASP	2.8
1	B	443	TRP	2.8
1	B	162	GLY	2.7
1	B	482	ILE	2.7
1	B	503	PRO	2.7
1	A	489	VAL	2.7
1	A	162	GLY	2.6
1	B	253	GLY	2.6
1	A	44	TYR	2.6
1	A	161	ALA	2.5
1	A	22	ASP	2.5
1	B	449	ARG	2.5
1	B	261	PRO	2.5
1	B	476	PRO	2.5
1	B	499	THR	2.5
1	B	518	ILE	2.5
1	B	19	ASP	2.5
1	A	500	TYR	2.5
1	B	507	GLN	2.5
1	B	446	THR	2.5
1	A	529	ALA	2.5
1	B	478	PHE	2.5
1	A	469	ASN	2.5
1	B	498	ASN	2.5
1	B	509	LYS	2.4
1	A	9	PRO	2.4
1	B	44	TYR	2.4
1	A	327	SER	2.4
1	B	469	ASN	2.4
1	B	490	ASP	2.4
1	B	540	LEU	2.4
1	B	399	THR	2.4
1	B	22	ASP	2.4
1	B	8	THR	2.4
1	B	484	THR	2.4
1	A	184	GLY	2.4
1	B	492	LYS	2.3
1	A	23	ILE	2.3

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Mol	Chain	Res	Type	RSRZ
1	B	491	THR	2.3
1	B	398	ILE	2.3
1	B	486	LEU	2.3
1	B	511	GLU	2.3
1	B	454	ASP	2.2
1	A	10	GLN	2.2
1	A	20	VAL	2.2
1	B	453	LYS	2.2
1	B	21	HIS	2.2
1	B	262	LYS	2.2
1	A	250	SER	2.2
1	B	531	ALA	2.2
1	B	487	PRO	2.2
1	B	366	GLY	2.2
1	B	14	ALA	2.1
1	A	474	THR	2.1
1	A	540	LEU	2.1
1	A	164	LYS	2.1
1	A	17	ILE	2.1
1	A	295	GLU	2.1
1	B	158	GLU	2.1
1	B	317	GLU	2.1
1	B	470	ALA	2.0
1	B	450	ILE	2.0
1	A	484	THR	2.0
1	B	182	GLU	2.0
1	A	167	PHE	2.0
1	B	195	LEU	2.0
1	B	477	MET	2.0
1	B	494	LEU	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 ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands

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	OAA	A	601	9/9	0.84	0.14	24,32,51,51	3
3	THJ	B	602	5/5	0.90	0.14	31,34,36,42	4
3	THJ	B	603	5/5	0.93	0.11	32,35,38,39	3
3	THJ	A	602	5/5	0.97	0.07	26,26,27,29	0
3	THJ	B	601	5/5	0.98	0.07	24,24,31,33	1

6.5 Other polymers

There are no such residues in this entry.