



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 03:55 AM UTC

PDB ID : 3G02 / pdb_00003g02
Title : Structure of enantioselective mutant of epoxide hydrolase from *Aspergillus niger* generated by directed evolution
Authors : Naworyta, A.; Mowbray, S.L.
Deposited on : 2009-01-27
Resolution : 1.50 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

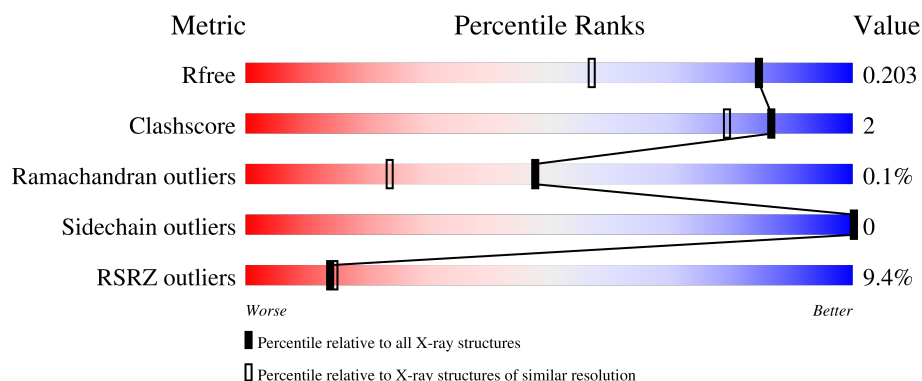
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.50 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}	180053	4037 (1.50-1.50)
Clashscore	190562	4235 (1.50-1.50)
Ramachandran outliers	187476	4153 (1.50-1.50)
Sidechain outliers	187428	4150 (1.50-1.50)
RSRZ outliers	180081	4039 (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 $\leq 5\%$. 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	408	8% 89% 5% 5%
1	B	408	9% 88% 5% 7%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 7069 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 Epoxide hydrolase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	387	Total	C	N	O	S	0	14	0
			3198	2082	515	590	11			
1	B	380	Total	C	N	O	S	0	14	0
			3156	2054	511	579	12			

There are 46 discrepancies between the modelled and reference sequences:

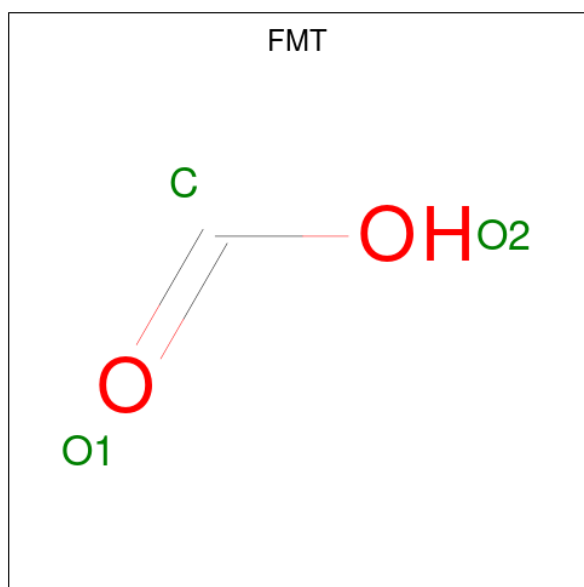
Chain	Residue	Modelled	Actual	Comment	Reference
A	0	MET	-	initiating methionine	UNP Q9UR30
A	1	ASN	-	expression tag	UNP Q9UR30
A	2	HIS	-	expression tag	UNP Q9UR30
A	3	LYS	-	expression tag	UNP Q9UR30
A	4	ALA	-	expression tag	UNP Q9UR30
A	215	PHE	LEU	engineered mutation	UNP Q9UR30
A	217	ASN	ALA	engineered mutation	UNP Q9UR30
A	219	SER	ARG	engineered mutation	UNP Q9UR30
A	249	TYR	LEU	engineered mutation	UNP Q9UR30
A	317	TRP	THR	engineered mutation	UNP Q9UR30
A	318	VAL	THR	engineered mutation	UNP Q9UR30
A	329	PRO	MET	engineered mutation	UNP Q9UR30
A	330	TYR	LEU	engineered mutation	UNP Q9UR30
A	350	VAL	CYS	engineered mutation	UNP Q9UR30
A	399	GLY	-	expression tag	UNP Q9UR30
A	400	ARG	-	expression tag	UNP Q9UR30
A	401	SER	-	expression tag	UNP Q9UR30
A	402	HIS	-	expression tag	UNP Q9UR30
A	403	HIS	-	expression tag	UNP Q9UR30
A	404	HIS	-	expression tag	UNP Q9UR30
A	405	HIS	-	expression tag	UNP Q9UR30
A	406	HIS	-	expression tag	UNP Q9UR30
A	407	HIS	-	expression tag	UNP Q9UR30
B	0	MET	-	initiating methionine	UNP Q9UR30
B	1	ASN	-	expression tag	UNP Q9UR30

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Chain	Residue	Modelled	Actual	Comment	Reference
B	2	HIS	-	expression tag	UNP Q9UR30
B	3	LYS	-	expression tag	UNP Q9UR30
B	4	ALA	-	expression tag	UNP Q9UR30
B	215	PHE	LEU	engineered mutation	UNP Q9UR30
B	217	ASN	ALA	engineered mutation	UNP Q9UR30
B	219	SER	ARG	engineered mutation	UNP Q9UR30
B	249	TYR	LEU	engineered mutation	UNP Q9UR30
B	317	TRP	THR	engineered mutation	UNP Q9UR30
B	318	VAL	THR	engineered mutation	UNP Q9UR30
B	329	PRO	MET	engineered mutation	UNP Q9UR30
B	330	TYR	LEU	engineered mutation	UNP Q9UR30
B	350	VAL	CYS	engineered mutation	UNP Q9UR30
B	399	GLY	-	expression tag	UNP Q9UR30
B	400	ARG	-	expression tag	UNP Q9UR30
B	401	SER	-	expression tag	UNP Q9UR30
B	402	HIS	-	expression tag	UNP Q9UR30
B	403	HIS	-	expression tag	UNP Q9UR30
B	404	HIS	-	expression tag	UNP Q9UR30
B	405	HIS	-	expression tag	UNP Q9UR30
B	406	HIS	-	expression tag	UNP Q9UR30
B	407	HIS	-	expression tag	UNP Q9UR30

- Molecule 2 is FORMIC ACID (CCD ID: FMT) (formula: CH₂O₂).



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

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

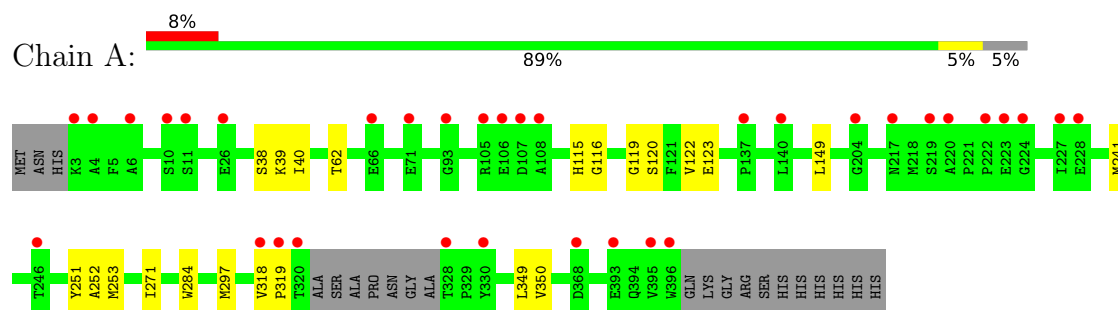
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	377	Total	O	0	0
			377	377		
3	B	329	Total	O	0	0
			329	329		

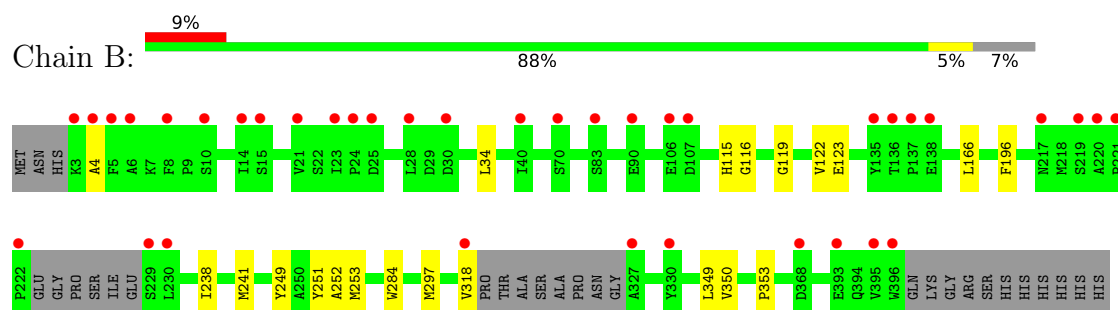
3 Residue-property plots [i](#)

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: Epoxide hydrolase



• Molecule 1: Epoxide hydrolase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	61.87Å 89.67Å 75.34Å 90.00° 104.79° 90.00°	Depositor
Resolution (Å)	28.91 – 1.50 28.91 – 1.50	Depositor EDS
% Data completeness (in resolution range)	95.0 (28.91-1.50) 95.0 (28.91-1.50)	Depositor EDS
R_{merge}	0.03	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	6.53 (at 1.50Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.183 , 0.204 0.183 , 0.203	Depositor DCC
R_{free} test set	6102 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	12.0	Xtriage
Anisotropy	0.028	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.41 , 43.1	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	0.96	EDS
Total number of atoms	7069	wwPDB-VP
Average B, all atoms (Å ²)	15.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.25% 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: FMT

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	0.42	0/3300	0.68	0/4494
1	B	0.41	0/3254	0.67	0/4425
All	All	0.41	0/6554	0.68	0/8919

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	3198	0	3104	16	0
1	B	3156	0	3057	11	0
2	A	6	0	2	0	0
2	B	3	0	1	0	0
3	A	377	0	0	2	0
3	B	329	0	0	0	0
All	All	7069	0	6164	26	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 2.

All (26) 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:253:MET:HG3	3:A:571:HOH:O	1.40	1.18
3:A:571:HOH:O	1:B:253[B]:MET:SD	2.37	0.83
1:A:39[A]:LYS:HE2	1:B:34:LEU:HD11	1.76	0.67
1:B:119:GLY:HA3	1:B:123[A]:GLU:OE1	1.95	0.65
1:A:119:GLY:HA3	1:A:123[B]:GLU:OE2	1.98	0.63
1:A:318[B]:VAL:CG2	1:A:319:PRO:HD3	2.35	0.57
1:A:40:ILE:HD13	1:A:62[B]:THR:CG2	2.34	0.56
1:A:318[B]:VAL:HG22	1:A:319:PRO:HD3	1.93	0.51
1:B:238:ILE:HD11	1:B:353:PRO:HD3	1.95	0.49
1:A:40:ILE:HD13	1:A:62[B]:THR:HG22	1.94	0.49
1:A:122[B]:VAL:HG13	1:A:297:MET:HE1	1.94	0.48
1:A:115:HIS:HD2	1:A:116:GLY:O	1.97	0.48
1:B:241[B]:MET:HG2	1:B:350:VAL:HG12	1.97	0.46
1:A:120:SER:OG	1:A:122[B]:VAL:HG12	2.16	0.45
1:B:115:HIS:HD2	1:B:116:GLY:O	2.01	0.43
1:B:166:LEU:HD13	1:B:196:PHE:CD2	2.53	0.43
1:B:251:TYR:CG	1:B:252:ALA:N	2.86	0.43
1:A:241[B]:MET:HG2	1:A:350:VAL:HG12	1.99	0.43
1:A:284:TRP:CG	1:A:349:LEU:HD21	2.54	0.43
1:B:284:TRP:CG	1:B:349:LEU:HD21	2.54	0.43
1:A:115:HIS:CE1	1:A:149:LEU:H	2.36	0.42
1:A:38[B]:SER:OG	1:A:271:ILE:HG13	2.18	0.42
1:B:249:TYR:HE2	1:B:318[A]:VAL:HG13	1.84	0.42
1:A:115:HIS:HE1	1:A:149:LEU:H	1.67	0.42
1:A:251:TYR:CG	1:A:252:ALA:N	2.88	0.41
1:B:122[B]:VAL:HG13	1:B:297:MET:HE1	2.02	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	397/408 (97%)	391 (98%)	6 (2%)	0	100	100
1	B	388/408 (95%)	382 (98%)	5 (1%)	1 (0%)	36	17
All	All	785/816 (96%)	773 (98%)	11 (1%)	1 (0%)	48	24

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	4	ALA

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	348/350 (99%)	348 (100%)	0	100	100
1	B	342/350 (98%)	342 (100%)	0	100	100
All	All	690/700 (99%)	690 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	115	HIS
1	A	217	ASN
1	B	17	ASN
1	B	115	HIS
1	B	169	ASN
1	B	175	GLN

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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

3 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	FMT	B	408	-	2,2,2	0.76	0	1,1,1	0.36	0
2	FMT	A	409	-	2,2,2	0.72	0	1,1,1	0.28	0
2	FMT	A	408	-	2,2,2	0.71	0	1,1,1	0.42	0

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 ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

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	387/408 (94%)	0.52	34 (8%) 15 17	3, 13, 22, 30	14 (3%)
1	B	380/408 (93%)	0.46	38 (10%) 12 13	3, 13, 24, 31	14 (3%)
All	All	767/816 (93%)	0.49	72 (9%) 14 14	3, 13, 23, 31	28 (3%)

All (72) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	4	ALA	5.3
1	A	328	THR	5.2
1	B	217[A]	ASN	4.8
1	A	368[A]	ASP	4.5
1	A	224	GLY	4.5
1	A	319	PRO	4.3
1	A	106	GLU	3.7
1	B	40[A]	ILE	3.5
1	B	327	ALA	3.5
1	B	3	LYS	3.5
1	A	227	ILE	3.5
1	B	220	ALA	3.5
1	A	26	GLU	3.4
1	B	396	TRP	3.4
1	A	3	LYS	3.3
1	B	330	TYR	3.2
1	A	246	THR	3.2
1	A	71	GLU	3.2
1	B	136	THR	3.2
1	B	222	PRO	3.2
1	A	320	THR	3.1
1	A	222	PRO	3.0
1	A	107	ASP	3.0
1	B	219	SER	3.0

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Mol	Chain	Res	Type	RSRZ
1	A	108	ALA	3.0
1	A	330	TYR	3.0
1	B	90	GLU	2.9
1	A	105	ARG	2.9
1	B	70	SER	2.9
1	B	106	GLU	2.8
1	B	107	ASP	2.7
1	B	230	LEU	2.7
1	B	393	GLU	2.7
1	A	318[A]	VAL	2.6
1	B	83	SER	2.6
1	A	93	GLY	2.6
1	A	395	VAL	2.6
1	B	10	SER	2.6
1	A	223	GLU	2.5
1	B	6	ALA	2.5
1	B	24	PRO	2.5
1	A	217	ASN	2.5
1	B	368	ASP	2.5
1	B	15	SER	2.4
1	A	10	SER	2.4
1	B	5	PHE	2.4
1	B	30	ASP	2.3
1	A	4	ALA	2.3
1	A	393	GLU	2.3
1	B	137	PRO	2.2
1	A	204	GLY	2.2
1	B	229	SER	2.2
1	A	140[A]	LEU	2.2
1	A	137	PRO	2.2
1	A	11	SER	2.2
1	B	28	LEU	2.2
1	B	14	ILE	2.2
1	B	221	PRO	2.2
1	B	23	ILE	2.1
1	A	66	GLU	2.1
1	B	395	VAL	2.1
1	A	219	SER	2.1
1	A	228	GLU	2.1
1	A	6	ALA	2.1
1	A	220	ALA	2.1
1	B	138	GLU	2.1

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Mol	Chain	Res	Type	RSRZ
1	B	8	PHE	2.0
1	B	21	VAL	2.0
1	A	396	TRP	2.0
1	B	318[A]	VAL	2.0
1	B	25	ASP	2.0
1	B	135	TYR	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	FMT	A	409	3/3	0.95	0.08	17,17,18,18	0
2	FMT	A	408	3/3	0.97	0.05	8,8,8,8	0
2	FMT	B	408	3/3	0.99	0.04	6,6,7,7	0

6.5 Other polymers [i](#)

There are no such residues in this entry.