



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 07:50 PM UTC

PDB ID : 7NEB / pdb_00007neb
Title : Crystal structure of branched-chain amino acid aminotransferase from *Thermobaculum terrenum* (M4 mutant)
Authors : Boyko, K.M.; Petrova, T.; Nikolaeva, A.Y.; Zeifman, Y.S.; Rakitina, T.V.; Suplatov, D.A.; Popov, V.O.; Bezsudnova, E.Y.
Deposited on : 2021-02-03
Resolution : 2.20 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

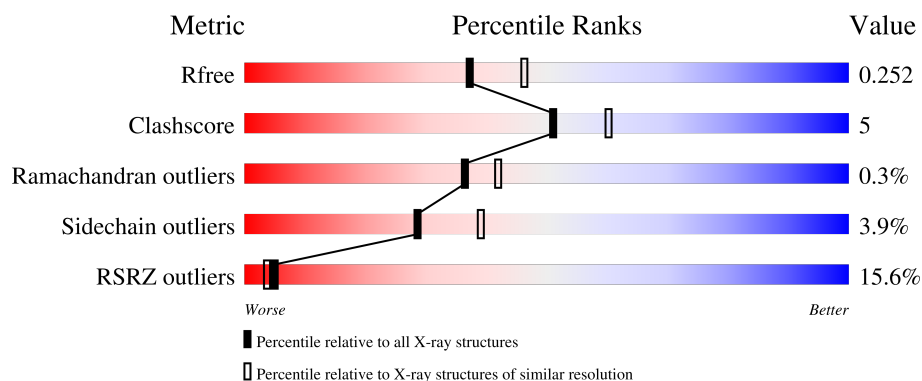
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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	6164 (2.20-2.20)
Clashscore	190562	6851 (2.20-2.20)
Ramachandran outliers	187476	6768 (2.20-2.20)
Sidechain outliers	187428	6769 (2.20-2.20)
RSRZ outliers	180081	6166 (2.20-2.20)

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	316	15% 75% 18% ...

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 2644 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.

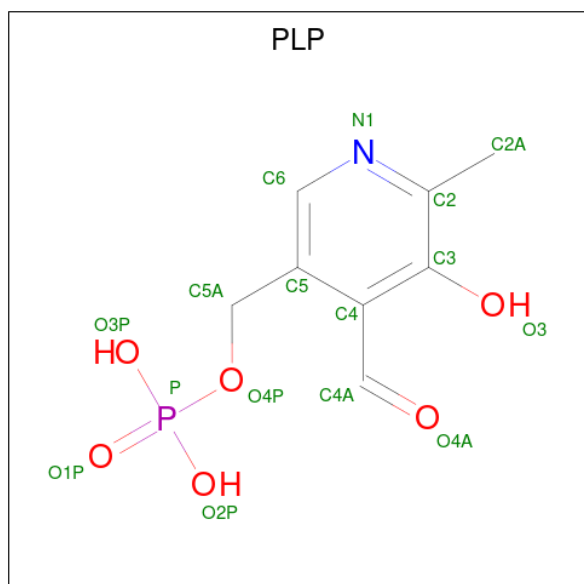
- Molecule 1 is a protein called Branched-chain-amino-acid aminotransferase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	302	2511	1601	436	460	14	0	14	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	41	VAL	GLY	engineered mutation	UNP D1CCW1
A	43	SER	ARG	engineered mutation	UNP D1CCW1
A	101	PHE	TYR	engineered mutation	UNP D1CCW1
A	115	ARG	SER	engineered mutation	UNP D1CCW1

- Molecule 2 is PYRIDOXAL-5'-PHOSPHATE (CCD ID: PLP) (formula: C₈H₁₀NO₆P).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
2	A	1	15	8	1	5	1	0	0

- Molecule 3 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total 1	Na 1	0	0

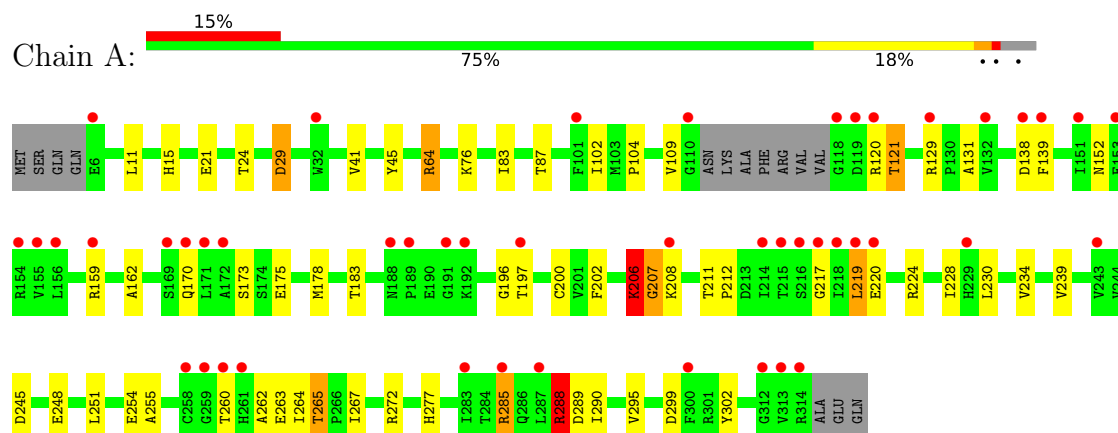
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	117	Total 117	O 117	0	0

3 Residue-property plots

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: Branched-chain-amino-acid aminotransferase



4 Data and refinement statistics

Property	Value	Source
Space group	H 3 2	Depositor
Cell constants a, b, c, α , β , γ	146.02Å 146.02Å 142.12Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	94.47 – 2.20 94.47 – 2.20	Depositor EDS
% Data completeness (in resolution range)	98.3 (94.47-2.20) 98.3 (94.47-2.20)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.11 (at 1.90Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.206 , 0.255 0.208 , 0.252	Depositor DCC
R_{free} test set	2289 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å ²)	41.4	Xtriage
Anisotropy	0.243	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 31.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	2644	wwPDB-VP
Average B, all atoms (Å ²)	51.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.26% 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: NA, PLP

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	1.37	14/2619 (0.5%)	1.61	24/3558 (0.7%)

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	4

All (14) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	15	HIS	CE1-NE2	8.01	1.40	1.32
1	A	41	VAL	C-O	6.80	1.31	1.24
1	A	109	VAL	C-O	6.70	1.31	1.24
1	A	197	THR	C-O	6.37	1.31	1.24
1	A	217	GLY	C-O	5.72	1.31	1.23
1	A	277	HIS	CE1-NE2	5.54	1.38	1.32
1	A	196	GLY	C-O	5.42	1.28	1.23
1	A	152	ASN	C-O	5.36	1.30	1.23
1	A	299	ASP	C-O	5.36	1.30	1.23
1	A	239	VAL	C-O	5.30	1.29	1.24
1	A	219	LEU	C-O	5.28	1.30	1.23
1	A	104	PRO	C-O	-5.18	1.18	1.23
1	A	272	ARG	C-O	-5.10	1.15	1.24
1	A	162	ALA	C-O	-5.03	1.18	1.23

All (24) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	24	THR	CA-CB-OG1	-10.56	93.75	109.60
1	A	302	TYR	CB-CA-C	7.30	122.78	111.02
1	A	121	THR	CB-CA-C	6.64	121.33	109.38
1	A	207	GLY	CA-C-N	6.44	131.61	122.72
1	A	207	GLY	C-N-CA	6.44	131.61	122.72
1	A	265	THR	CB-CA-C	6.32	117.18	110.17
1	A	21	GLU	CB-CG-CD	6.30	123.32	112.60
1	A	212	PRO	CA-C-O	-6.10	114.38	121.34
1	A	260	THR	CA-C-O	-6.02	114.68	121.00
1	A	211	THR	CB-CA-C	5.66	117.66	109.45
1	A	131	ALA	CA-C-O	-5.47	114.37	120.66
1	A	21	GLU	N-CA-C	-5.43	106.61	113.18
1	A	260	THR	CB-CA-C	5.29	119.10	110.96
1	A	228	ILE	CA-C-O	-5.19	115.67	121.17
1	A	224	ARG	N-CA-C	-5.17	105.54	111.07
1	A	267	ILE	CA-C-N	5.17	127.63	120.29
1	A	267	ILE	C-N-CA	5.17	127.63	120.29
1	A	288[A]	ARG	CA-C-O	-5.16	115.08	120.55
1	A	288[B]	ARG	CA-C-O	-5.16	115.08	120.55
1	A	120	ARG	CB-CA-C	5.14	118.26	109.72
1	A	29[A]	ASP	CA-CB-CG	-5.13	107.47	112.60
1	A	29[B]	ASP	CA-CB-CG	-5.13	107.47	112.60
1	A	64	ARG	CB-CA-C	5.08	119.22	110.79
1	A	183	THR	CA-CB-OG1	-5.04	102.05	109.60

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	206	LYS	Peptide
1	A	29[A]	ASP	Peptide,Mainchain
1	A	29[B]	ASP	Peptide

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	2511	0	2446	26	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	A	15	0	6	1	0
3	A	1	0	0	0	0
4	A	117	0	0	1	0
All	All	2644	0	2452	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 5.

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:288[B]:ARG:HH21	1:A:288[B]:ARG:HG2	1.26	1.00
1:A:170:GLN:HA	1:A:173:SER:OG	1.88	0.71
1:A:129[B]:ARG:HG3	1:A:129[B]:ARG:HH11	1.55	0.69
1:A:288[B]:ARG:HG2	1:A:288[B]:ARG:NH2	2.03	0.66
1:A:288[B]:ARG:HH21	1:A:288[B]:ARG:CG	2.00	0.62
1:A:129[B]:ARG:HG3	1:A:129[B]:ARG:NH1	2.14	0.61
1:A:175:GLU:HA	1:A:178:MET:HE3	1.84	0.60
1:A:64:ARG:NH2	2:A:401:PLP:O3P	2.33	0.59
1:A:288[B]:ARG:NH2	1:A:288[B]:ARG:CG	2.62	0.55
1:A:139:PHE:CE2	1:A:265:THR:HG23	2.41	0.55
1:A:264:ILE:HB	1:A:288[A]:ARG:HD3	1.91	0.53
1:A:138:ASP:OD2	1:A:285[B]:ARG:NH2	2.42	0.52
1:A:129[B]:ARG:NH1	1:A:129[B]:ARG:CG	2.72	0.51
1:A:234:VAL:HG11	1:A:290:ILE:HD13	1.92	0.51
1:A:159:ARG:NH1	1:A:220[A]:GLU:CD	2.72	0.48
1:A:45:TYR:CD2	1:A:295:VAL:HB	2.48	0.47
1:A:230:LEU:HD13	1:A:290:ILE:HG22	1.98	0.46
1:A:87:THR:HG23	1:A:102:ILE:HG21	1.97	0.45
1:A:288[B]:ARG:NH2	1:A:289:ASP:OD1	2.40	0.44
1:A:202:PHE:O	1:A:255:ALA:HA	2.17	0.44
1:A:11:LEU:HD12	1:A:11:LEU:C	2.42	0.43
1:A:262:ALA:O	1:A:263:GLU:C	2.62	0.43
1:A:207:GLY:HA3	4:A:541:HOH:O	2.19	0.42
1:A:288[A]:ARG:HH21	1:A:288[A]:ARG:HD2	1.61	0.42
1:A:245:ASP:O	1:A:248:GLU:HG2	2.21	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	312/316 (99%)	294 (94%)	17 (5%)	1 (0%)	36	42

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	206	LYS

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	270/272 (99%)	258 (96%)	12 (4%)	25	34

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	76	LYS
1	A	83	ILE
1	A	121	THR
1	A	206	LYS
1	A	208	LYS
1	A	219	LEU
1	A	251	LEU
1	A	254	GLU
1	A	285[A]	ARG
1	A	285[B]	ARG

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Mol	Chain	Res	Type
1	A	288[A]	ARG
1	A	288[B]	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	273	HIS

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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 1 is monoatomic - leaving 1 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	$\# Z > 2$
2	PLP	A	401	1	15,15,16	1.08	2 (13%)	21,22,23	1.06	1 (4%)

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	PLP	A	401	1	-	1/6/6/8	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	401	PLP	P-O4P	2.47	1.68	1.60
2	A	401	PLP	C4A-C4	-2.14	1.47	1.51

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	401	PLP	O4P-C5A-C5	3.46	115.84	109.36

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	401	PLP	C4-C5-C5A-O4P

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	401	PLP	1	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	302/316 (95%)	0.79	47 (15%) 5 4	25, 50, 75, 118	14 (4%)

All (47) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	172	ALA	7.1
1	A	132	VAL	6.0
1	A	118	GLY	5.8
1	A	171	LEU	5.3
1	A	313	VAL	5.0
1	A	139	PHE	4.7
1	A	189	PRO	4.7
1	A	216	SER	4.6
1	A	6	GLU	4.5
1	A	220[A]	GLU	4.3
1	A	219	LEU	4.2
1	A	215	THR	4.1
1	A	155	VAL	3.8
1	A	314	ARG	3.7
1	A	120	ARG	3.7
1	A	159	ARG	3.7
1	A	285[A]	ARG	3.6
1	A	261	HIS	3.3
1	A	110	GLY	3.3
1	A	258[A]	CYS	3.1
1	A	191	GLY	3.0
1	A	156	LEU	2.9
1	A	217	GLY	2.9
1	A	101	PHE	2.9
1	A	259	GLY	2.8
1	A	151	ILE	2.8
1	A	312	GLY	2.8

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Mol	Chain	Res	Type	RSRZ
1	A	197	THR	2.7
1	A	260	THR	2.6
1	A	154	ARG	2.5
1	A	32[A]	TRP	2.4
1	A	300[A]	PHE	2.4
1	A	283	ILE	2.4
1	A	138	ASP	2.3
1	A	129[A]	ARG	2.3
1	A	192	LYS	2.2
1	A	153	GLU	2.2
1	A	170	GLN	2.2
1	A	169[A]	SER	2.2
1	A	218	ILE	2.1
1	A	243	VAL	2.1
1	A	229	HIS	2.1
1	A	214	ILE	2.1
1	A	188	ASN	2.1
1	A	208	LYS	2.1
1	A	119	ASP	2.0
1	A	287	LEU	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	PLP	A	401	15/16	0.92	0.13	45,63,72,73	0
3	NA	A	402	1/1	0.97	0.10	34,34,34,34	0

6.5 Other polymers [i](#)

There are no such residues in this entry.