



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 04:28 PM UTC

PDB ID : 4FXU / pdb_00004fxu
Title : Crystallographic structure of trimeric riboflavin synthase from *Brucella abortus*
Authors : Serer, M.I.; Bonomi, H.R.; Guimaraes, B.G.; Rossi, R.C.; Goldbaum, F.A.; Klinke, S.
Deposited on : 2012-07-03
Resolution : 1.90 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
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

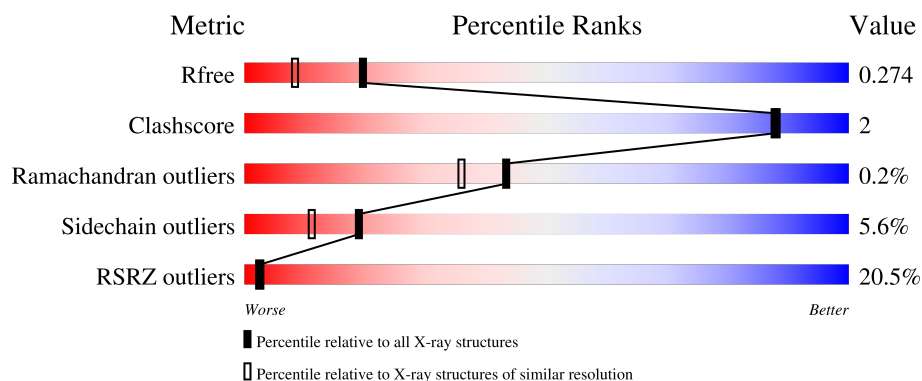
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.90 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	7789 (1.90-1.90)
Clashscore	190562	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)
RSRZ outliers	180081	7790 (1.90-1.90)

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	210	
1	B	210	
1	C	210	

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4291 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 Riboflavin synthase subunit alpha.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	194	Total	C	N	O	S	0	0	0
			1460	925	253	278	4			
1	B	169	Total	C	N	O	S	0	0	0
			1189	746	206	233	4			
1	C	197	Total	C	N	O	S	0	0	0
			1494	940	260	290	4			

There are 24 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	203	LEU	-	expression tag	UNP G8SX20
A	204	GLU	-	expression tag	UNP G8SX20
A	205	HIS	-	expression tag	UNP G8SX20
A	206	HIS	-	expression tag	UNP G8SX20
A	207	HIS	-	expression tag	UNP G8SX20
A	208	HIS	-	expression tag	UNP G8SX20
A	209	HIS	-	expression tag	UNP G8SX20
A	210	HIS	-	expression tag	UNP G8SX20
B	203	LEU	-	expression tag	UNP G8SX20
B	204	GLU	-	expression tag	UNP G8SX20
B	205	HIS	-	expression tag	UNP G8SX20
B	206	HIS	-	expression tag	UNP G8SX20
B	207	HIS	-	expression tag	UNP G8SX20
B	208	HIS	-	expression tag	UNP G8SX20
B	209	HIS	-	expression tag	UNP G8SX20
B	210	HIS	-	expression tag	UNP G8SX20
C	203	LEU	-	expression tag	UNP G8SX20
C	204	GLU	-	expression tag	UNP G8SX20
C	205	HIS	-	expression tag	UNP G8SX20
C	206	HIS	-	expression tag	UNP G8SX20
C	207	HIS	-	expression tag	UNP G8SX20
C	208	HIS	-	expression tag	UNP G8SX20
C	209	HIS	-	expression tag	UNP G8SX20

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Chain	Residue	Modelled	Actual	Comment	Reference
C	210	HIS	-	expression tag	UNP G8SX20

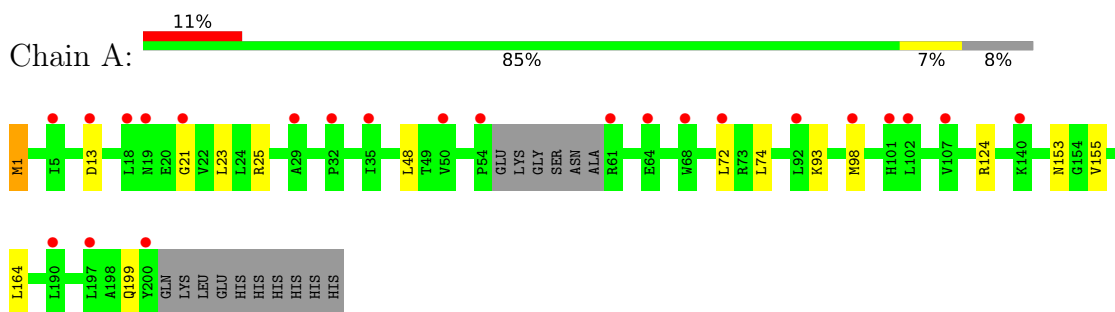
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	67	Total 67	O 67	0	0
2	B	16	Total 16	O 16	0	0
2	C	65	Total 65	O 65	0	0

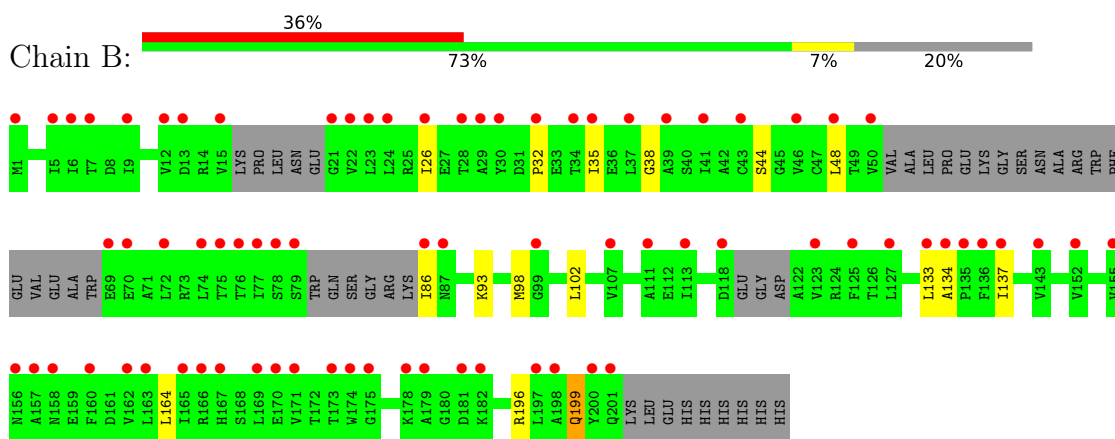
3 Residue-property plots [i](#)

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.

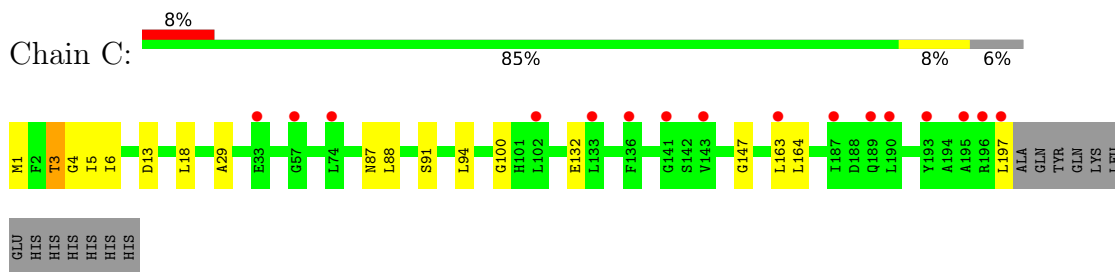
- Molecule 1: Riboflavin synthase subunit alpha



- Molecule 1: Riboflavin synthase subunit alpha



- Molecule 1: Riboflavin synthase subunit alpha



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	67.42Å 93.48Å 103.30Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	27.72 – 1.90 27.72 – 1.90	Depositor EDS
% Data completeness (in resolution range)	99.9 (27.72-1.90) 99.9 (27.72-1.90)	Depositor EDS
R_{merge}	0.04	Depositor
R_{sym}	0.04	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.85 (at 1.91Å)	Xtriage
Refinement program	BUSTER 2.10.0	Depositor
R, R_{free}	0.232 , 0.264 0.240 , 0.274	Depositor DCC
R_{free} test set	2606 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	41.2	Xtriage
Anisotropy	0.153	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 40.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	4291	wwPDB-VP
Average B, all atoms (Å ²)	50.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.94% 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 [i](#)

5.1 Standard geometry [i](#)

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	0.84	1/1483 (0.1%)	1.11	1/2015 (0.0%)
1	B	0.84	0/1200	1.19	2/1631 (0.1%)
1	C	0.88	1/1517 (0.1%)	1.12	1/2060 (0.0%)
All	All	0.85	2/4200 (0.0%)	1.14	4/5706 (0.1%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	1	MET	SD-CE	-5.46	1.66	1.79
1	C	88	LEU	CA-C	-5.08	1.46	1.52

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	98	MET	N-CA-C	-6.33	98.93	109.24
1	C	29	ALA	N-CA-C	-5.47	106.66	113.38
1	B	38	GLY	CA-C-N	5.15	128.53	120.75
1	B	38	GLY	C-N-CA	5.15	128.53	120.75

There are no chirality outliers.

There are no planarity outliers.

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	1460	0	1435	8	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	1189	0	1107	5	0
1	C	1494	0	1475	4	0
2	A	67	0	0	0	0
2	B	16	0	0	0	0
2	C	65	0	0	0	0
All	All	4291	0	4017	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 2.

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:124:ARG:HH22	1:A:153:ASN:ND2	1.52	1.06
1:A:124:ARG:NH2	1:A:153:ASN:ND2	2.30	0.77
1:A:124:ARG:NH2	1:A:153:ASN:HD22	1.91	0.67
1:A:124:ARG:HH22	1:A:153:ASN:HD22	1.37	0.63
1:C:3:THR:HB	1:C:5:ILE:HD12	1.80	0.63
1:B:26:ILE:HG12	1:B:86:ILE:HD11	1.85	0.58
1:B:32:PRO:HA	1:B:35:ILE:HD12	1.88	0.56
1:B:196:ARG:HA	1:B:199:GLN:HG2	1.89	0.55
1:C:5:ILE:HD11	1:C:100:GLY:N	2.24	0.53
1:A:1:MET:HE3	1:B:98:MET:HB3	1.95	0.49
1:A:13:ASP:CG	1:A:25:ARG:HH21	2.20	0.49
1:A:124:ARG:HH22	1:A:153:ASN:HD21	1.53	0.46
1:C:6:ILE:HD12	1:C:87:ASN:HB3	1.98	0.45
1:A:21:GLY:H	1:A:72:LEU:HD13	1.84	0.43
1:B:134:ALA:HA	1:B:137:ILE:HD12	2.00	0.42
1:C:4:GLY:HA2	1:C:147:GLY:O	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	190/210 (90%)	185 (97%)	4 (2%)	1 (0%)	24	16
1	B	159/210 (76%)	155 (98%)	4 (2%)	0	100	100
1	C	195/210 (93%)	191 (98%)	4 (2%)	0	100	100
All	All	544/630 (86%)	531 (98%)	12 (2%)	1 (0%)	43	36

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	199	GLN

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	148/173 (86%)	142 (96%)	6 (4%)	27	19
1	B	111/173 (64%)	104 (94%)	7 (6%)	16	8
1	C	155/173 (90%)	145 (94%)	10 (6%)	15	8
All	All	414/519 (80%)	391 (94%)	23 (6%)	19	11

All (23) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	23	LEU
1	A	48	LEU
1	A	74	LEU
1	A	93	LYS
1	A	155	VAL
1	A	164	LEU
1	B	44	SER
1	B	48	LEU
1	B	93	LYS

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Mol	Chain	Res	Type
1	B	102	LEU
1	B	133	LEU
1	B	164	LEU
1	B	199	GLN
1	C	1	MET
1	C	3	THR
1	C	13	ASP
1	C	18	LEU
1	C	91	SER
1	C	94	LEU
1	C	132	GLU
1	C	163	LEU
1	C	164	LEU
1	C	197	LEU

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	153	ASN
1	B	139	GLN
1	B	189	GLN
1	C	189	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 ⓘ

There are no ligands in this entry.

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	194/210 (92%)	0.80	23 (11%) 9 9	31, 45, 64, 91	0
1	B	169/210 (80%)	1.92	76 (44%) 0 0	39, 63, 93, 107	0
1	C	197/210 (93%)	0.67	16 (8%) 18 19	28, 42, 60, 91	0
All	All	560/630 (88%)	1.09	115 (20%) 2 2	28, 48, 79, 107	0

All (115) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	15	VAL	7.4
1	B	50	VAL	6.4
1	B	111	ALA	4.9
1	B	134	ALA	4.8
1	A	200	TYR	4.5
1	B	201	GLN	4.4
1	C	197	LEU	4.2
1	C	102	LEU	4.1
1	C	193	TYR	4.0
1	B	133	LEU	4.0
1	A	101	HIS	3.9
1	C	136	PHE	3.7
1	B	35	ILE	3.7
1	B	125	PHE	3.7
1	B	12	VAL	3.7
1	B	72	LEU	3.6
1	B	41	ILE	3.6
1	C	57	GLY	3.6
1	B	48	LEU	3.6
1	B	197	LEU	3.5
1	A	68	TRP	3.5
1	B	77	ILE	3.5
1	B	86	ILE	3.5

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Mol	Chain	Res	Type	RSRZ
1	B	113	ILE	3.4
1	B	23	LEU	3.4
1	B	175	GLY	3.3
1	B	79	SER	3.3
1	B	179	ALA	3.3
1	B	174	TRP	3.3
1	B	165	ILE	3.2
1	A	54	PRO	3.2
1	C	196	ARG	3.2
1	C	133	LEU	3.1
1	A	107	VAL	3.1
1	B	46	VAL	3.1
1	B	22	VAL	3.1
1	B	155	VAL	3.1
1	A	190	LEU	3.0
1	A	29	ALA	3.0
1	B	200	TYR	3.0
1	B	37	LEU	3.0
1	B	13	ASP	3.0
1	B	118	ASP	3.0
1	A	19	ASN	3.0
1	B	137	ILE	2.9
1	A	72	LEU	2.9
1	B	29	ALA	2.8
1	B	6	ILE	2.8
1	B	76	THR	2.8
1	B	7	THR	2.8
1	B	43	CYS	2.7
1	B	136	PHE	2.7
1	B	24	LEU	2.7
1	B	163	LEU	2.7
1	C	189	GLN	2.7
1	B	32	PRO	2.7
1	B	158	ASN	2.6
1	B	157	ALA	2.6
1	B	166	ARG	2.6
1	B	87	ASN	2.6
1	B	170	GLU	2.5
1	B	169	LEU	2.5
1	B	26	ILE	2.5
1	B	127	LEU	2.5
1	B	69	GLU	2.5

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Mol	Chain	Res	Type	RSRZ
1	A	197	LEU	2.5
1	B	99	GLY	2.5
1	C	195	ALA	2.5
1	B	152	VAL	2.5
1	B	21	GLY	2.4
1	A	98	MET	2.4
1	B	198	ALA	2.4
1	B	160	PHE	2.4
1	C	141	GLY	2.4
1	B	182	LYS	2.4
1	B	5	ILE	2.4
1	B	143	VAL	2.4
1	C	190	LEU	2.3
1	B	9	ILE	2.3
1	B	156	ASN	2.3
1	A	13	ASP	2.3
1	B	28	THR	2.3
1	B	135	PRO	2.3
1	A	21	GLY	2.3
1	B	162	VAL	2.3
1	C	33	GLU	2.3
1	A	18	LEU	2.3
1	B	75	THR	2.3
1	B	178	LYS	2.3
1	C	187	ILE	2.3
1	B	74	LEU	2.3
1	B	173	THR	2.3
1	A	32	PRO	2.2
1	B	78	SER	2.2
1	B	70	GLU	2.2
1	B	30	TYR	2.2
1	B	167	HIS	2.2
1	A	50	VAL	2.2
1	C	163	LEU	2.2
1	A	64	GLU	2.2
1	B	107	VAL	2.2
1	B	123	VAL	2.2
1	C	74	LEU	2.2
1	B	39	ALA	2.2
1	B	181	ASP	2.1
1	B	1	MET	2.1
1	A	5	ILE	2.1

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Mol	Chain	Res	Type	RSRZ
1	A	92	LEU	2.1
1	A	102	LEU	2.1
1	A	35	ILE	2.1
1	B	34	THR	2.1
1	A	61	ARG	2.1
1	B	171	VAL	2.0
1	C	143	VAL	2.0
1	A	140	LYS	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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.