Full wwPDB X-ray Structure Validation Report ⓘ

May 14, 2026 – 01:36 pm BST

PDB ID	:	9HMI / pdb_00009hmi
Title	:	Crystal structure of the Calf domains of Integrin Alpha5 in complex with angiopoietin2 peptide
Authors	:	Murthy, A.V.; Sipila, T.J.O.; Ponna, S.K.; Leppanen, V.M.L.; Saharinen, P.I.
Deposited on	:	2024-12-09
Resolution	:	2.78 Å(reported)

The following versions of software and data (see references ⓘ) were used in the production of this report:

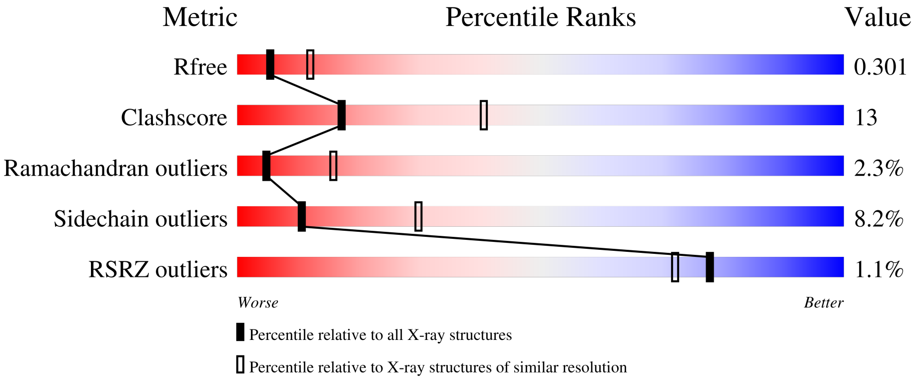
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (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

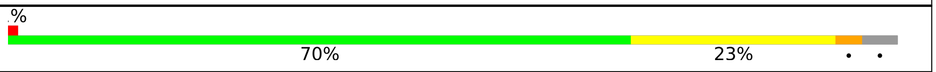
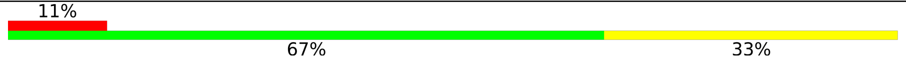
The reported resolution of this entry is 2.78 Å.

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	5248 (2.80-2.76)
Clashscore	190562	5693 (2.80-2.76)
Ramachandran outliers	187476	5590 (2.80-2.76)
Sidechain outliers	187428	5592 (2.80-2.76)
RSRZ outliers	180081	5251 (2.80-2.76)

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 <=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	359	
2	P	9	

2 Entry composition ⓘ

There are 4 unique types of molecules in this entry. The entry contains 2896 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 Integrin alpha-5.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	346	Total 2711	C 1701	N 483	O 515	S 12	0	0	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-5	HIS	-	expression tag	UNP P08648
A	-4	HIS	-	expression tag	UNP P08648
A	-3	HIS	-	expression tag	UNP P08648
A	-2	HIS	-	expression tag	UNP P08648
A	-1	HIS	-	expression tag	UNP P08648
A	0	HIS	-	expression tag	UNP P08648

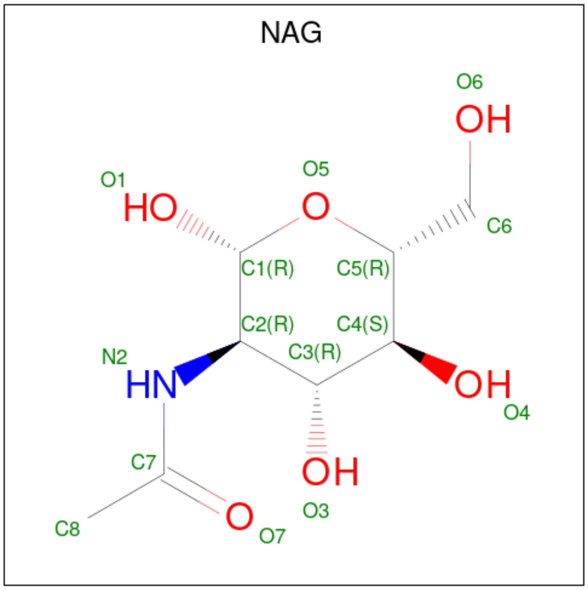
- Molecule 2 is a protein called Angiopoietin-2.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	P	9	Total 62	C 36	N 12	O 14	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
P	358	ALA	-	expression tag	UNP O15123

- Molecule 3 is 2-acetamido-2-deoxy-beta-D-glucopyranose (CCD ID: NAG) (formula: $C_8H_{15}NO_6$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
3	A	1	15	8	1	6	0	0

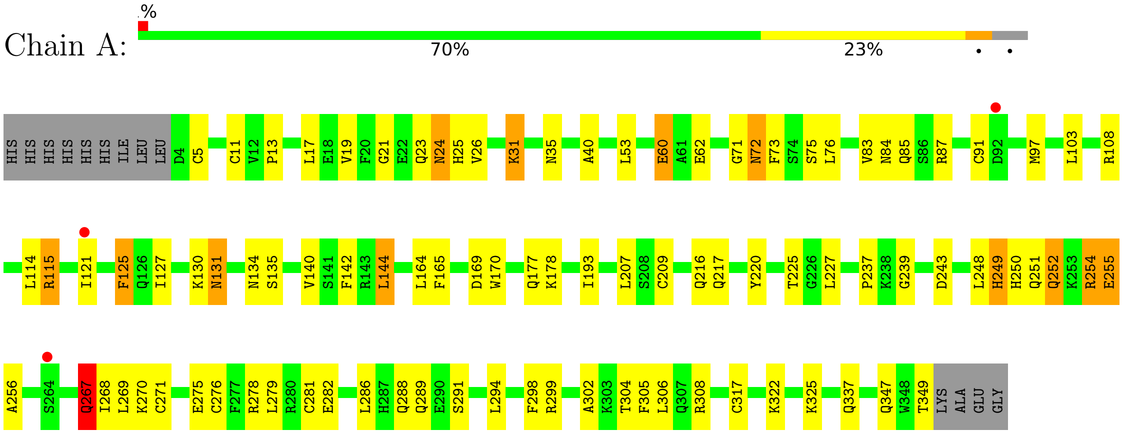
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	108	108	108	0	0

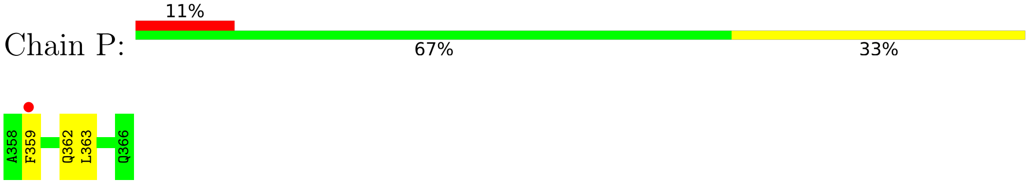
3 Residue-property plots ⓘ

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: Integrin alpha-5



- Molecule 2: Angiopoietin-2



4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	49.98Å 69.23Å 137.83Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.84 – 2.78 48.84 – 2.78	Depositor EDS
% Data completeness (in resolution range)	97.6 (48.84-2.78) 97.6 (48.84-2.78)	Depositor EDS
R_{merge}	0.20	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	0.97 (at 2.77Å)	Xtriage
Refinement program	REFMAC 5.8.0411	Depositor
R, R_{free}	0.204 , 0.306 0.210 , 0.301	Depositor DCC
R_{free} test set	610 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å^2)	90.2	Xtriage
Anisotropy	0.365	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.31 , 95.8	EDS
L-test for twinning[2]	$< \lvert L \rvert > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	2896	wwPDB-VP
Average B, all atoms (Å^2)	116.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.61% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< \lvert L \rvert >$, $< L^2 >$ 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: NAG

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	0.52	0/2776	0.97	4/3775 (0.1%)
2	P	0.52	0/61	1.06	0/82
All	All	0.52	0/2837	0.98	4/3857 (0.1%)

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	169	ASP	CA-CB-CG	6.15	118.75	112.60
1	A	131	ASN	CB-CA-C	-5.71	100.47	111.78
1	A	249	HIS	CA-CB-CG	5.21	119.01	113.80
1	A	298	PHE	CA-CB-CG	5.07	118.87	113.80

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	2711	0	2635	65	0
2	P	62	0	53	0	0
3	A	15	0	15	0	0
4	A	108	0	0	4	1
All	All	2896	0	2703	65	1

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 13.

All (65) 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:271:CYS:HB2	1:A:276:CYS:SG	2.17	0.85
1:A:26:VAL:HG23	1:A:114:LEU:HD21	1.67	0.77
1:A:268:ILE:HD12	1:A:268:ILE:O	1.87	0.75
1:A:35:ASN:ND2	1:A:108:ARG:HG2	2.04	0.72
1:A:271:CYS:SG	1:A:278:ARG:NH1	2.62	0.72
1:A:35:ASN:HD22	1:A:108:ARG:HG2	1.56	0.71
1:A:271:CYS:CB	1:A:276:CYS:SG	2.79	0.70
1:A:305:PHE:O	1:A:306:LEU:HB2	1.92	0.69
1:A:97:MET:HE3	1:A:103:LEU:HD12	1.77	0.66
1:A:267:GLN:HE22	1:A:269:LEU:HG	1.61	0.65
1:A:267:GLN:CD	1:A:267:GLN:C	2.65	0.65
1:A:71:GLY:O	1:A:72:ASN:HB2	1.97	0.63
1:A:97:MET:HE3	1:A:103:LEU:CD1	2.29	0.62
1:A:19:VAL:HG22	1:A:140:VAL:CG1	2.30	0.61
1:A:250:HIS:CE1	4:A:520:HOH:O	2.52	0.61
1:A:302:ALA:O	1:A:305:PHE:O	2.19	0.61
1:A:220:TYR:CZ	1:A:237:PRO:HD2	2.38	0.59
1:A:130:LYS:HA	1:A:134:ASN:HD22	1.68	0.58
1:A:130:LYS:HA	1:A:134:ASN:ND2	2.18	0.58
1:A:164:LEU:HD23	1:A:347:GLN:HG3	1.85	0.58
1:A:217:GLN:O	1:A:304:THR:OG1	2.15	0.56
1:A:254:ARG:HB2	1:A:254:ARG:HH21	1.70	0.55
1:A:305:PHE:HA	4:A:524:HOH:O	2.05	0.55
1:A:5:CYS:HG	1:A:11:CYS:HG	0.56	0.55
1:A:19:VAL:HG22	1:A:140:VAL:HG12	1.90	0.54
1:A:72:ASN:O	1:A:73:PHE:HB3	2.08	0.53
1:A:131:ASN:HB2	1:A:134:ASN:H	1.76	0.51
1:A:271:CYS:SG	1:A:276:CYS:SG	3.09	0.51
1:A:134:ASN:O	1:A:135:SER:C	2.55	0.50
1:A:19:VAL:HG22	1:A:140:VAL:HG11	1.93	0.50
1:A:26:VAL:CG2	1:A:114:LEU:HD21	2.40	0.49
1:A:19:VAL:CG2	1:A:140:VAL:HG12	2.43	0.48
1:A:249:HIS:NE2	1:A:252:GLN:HG2	2.29	0.48
1:A:164:LEU:HA	1:A:347:GLN:O	2.14	0.47
1:A:26:VAL:HG21	1:A:121:ILE:CD1	2.44	0.47
1:A:255:GLU:HA	1:A:347:GLN:HE22	1.80	0.47
1:A:13:PRO:HD2	1:A:135:SER:OG	2.14	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:216:GLN:NE2	1:A:308:ARG:HH22	2.12	0.47
1:A:83:VAL:HG23	1:A:84:ASN:OD1	2.14	0.46
1:A:243:ASP:OD2	1:A:299:ARG:NH2	2.48	0.46
1:A:21:GLY:HA3	1:A:142:PHE:CZ	2.51	0.46
1:A:165:PHE:O	1:A:349:THR:N	2.44	0.45
1:A:305:PHE:O	1:A:306:LEU:CB	2.64	0.45
1:A:60:GLU:OE1	1:A:115:ARG:NH1	2.50	0.44
1:A:209:CYS:SG	1:A:317:CYS:CB	3.06	0.44
1:A:17:LEU:HD21	1:A:125:PHE:HB3	2.00	0.44
1:A:207:LEU:HD11	1:A:317:CYS:HB3	1.99	0.44
1:A:268:ILE:HD13	1:A:270:LYS:NZ	2.33	0.44
1:A:24:ASN:O	1:A:144:LEU:HA	2.17	0.44
1:A:17:LEU:O	1:A:140:VAL:HG21	2.18	0.44
1:A:84:ASN:OD1	1:A:85:GLN:N	2.45	0.43
1:A:216:GLN:HE22	1:A:308:ARG:HH22	1.65	0.43
1:A:40:ALA:HB1	1:A:127:ILE:HD11	2.00	0.43
1:A:227:LEU:HD12	1:A:294:LEU:HB2	2.01	0.42
1:A:220:TYR:CE1	1:A:237:PRO:HD2	2.55	0.42
1:A:177:GLN:HG3	1:A:178:LYS:HG3	2.00	0.42
1:A:288:GLN:HG2	1:A:289:GLN:HG2	2.02	0.41
1:A:286:LEU:HD23	1:A:286:LEU:HA	1.88	0.41
1:A:26:VAL:HG21	1:A:121:ILE:HD11	2.02	0.41
1:A:308:ARG:NE	4:A:516:HOH:O	2.52	0.41
1:A:322:LYS:HG2	1:A:337:GLN:HG3	2.03	0.41
1:A:53:LEU:HB3	1:A:91:CYS:HB2	2.03	0.40
1:A:31:LYS:HE3	1:A:31:LYS:HA	2.02	0.40
1:A:87:ARG:NE	4:A:507:HOH:O	2.43	0.40
1:A:267:GLN:C	1:A:267:GLN:NE2	2.79	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:A:553:HOH:O	4:A:598:HOH:O[4_555]	2.18	0.02

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	344/359 (96%)	316 (92%)	21 (6%)	7 (2%)	6	18
2	P	7/9 (78%)	5 (71%)	1 (14%)	1 (14%)	0	0
All	All	351/368 (95%)	321 (92%)	22 (6%)	8 (2%)	5	16

All (8) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	72	ASN
1	A	239	GLY
1	A	75	SER
1	A	255	GLU
1	A	267	GLN
2	P	359	PHE
1	A	170	TRP
1	A	256	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	300/313 (96%)	277 (92%)	23 (8%)	12	33
2	P	6/8 (75%)	4 (67%)	2 (33%)	0	0
All	All	306/321 (95%)	281 (92%)	25 (8%)	10	30

All (25) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	23	GLN
1	A	24	ASN
1	A	25	HIS
1	A	31	LYS
1	A	60	GLU
1	A	62	GLU
1	A	76	LEU
1	A	115	ARG
1	A	125	PHE
1	A	144	LEU
1	A	193	ILE
1	A	225	THR
1	A	248	LEU
1	A	251	GLN
1	A	252	GLN
1	A	254	ARG
1	A	267	GLN
1	A	275	GLU
1	A	279	LEU
1	A	281	CYS
1	A	282	GLU
1	A	291	SER
1	A	325	LYS
2	P	362	GLN
2	P	363	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (11) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	16	GLN
1	A	35	ASN
1	A	72	ASN
1	A	134	ASN
1	A	216	GLN
1	A	252	GLN
1	A	267	GLN
1	A	295	GLN
1	A	297	HIS
1	A	341	GLN
1	A	347	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

1 ligand is 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	NAG	A	401	-	15,15,15	0.21	0	21,21,21	0.94	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
3	NAG	A	401	-	-	2/6/26/26	0/1/1/1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	A	401	NAG	O5-C1-C2	3.54	113.07	109.52

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	401	NAG	C8-C7-N2-C2
3	A	401	NAG	O7-C7-N2-C2

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	346/359 (96%)	-0.39	3 (0%)	81	76	66, 102, 197, 260	0
2	P	9/9 (100%)	0.76	1 (11%)	10	8	147, 172, 233, 237	0
All	All	355/368 (96%)	-0.36	4 (1%)	78	72	66, 102, 206, 260	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	264	SER	3.0
2	P	359	PHE	2.6
1	A	121	ILE	2.4
1	A	92	ASP	2.2

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
3	NAG	A	401	15/15	0.13	0.22	387,417,425,425	0

6.5 Other polymers ⓘ

There are no such residues in this entry.