



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 20, 2026 – 01:07 AM UTC

PDB ID : 5BW2 / pdb_00005bw2
Title : X-ray crystal structure of Aplysia californica acetylcholine binding protein (Ac-AChBP) Y55W in complex with 2-Pyridin-3-yl-1-aza-bicyclo[2.2.2]octane; 2-(3-pyridyl)quinuclidine; 2-PQ (TI-4699)
Authors : Bobango, J.; Sankaran, B.; Park, J.F.; Wu, J.; Talley, T.T.
Deposited on : 2015-06-05
Resolution : 2.27 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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

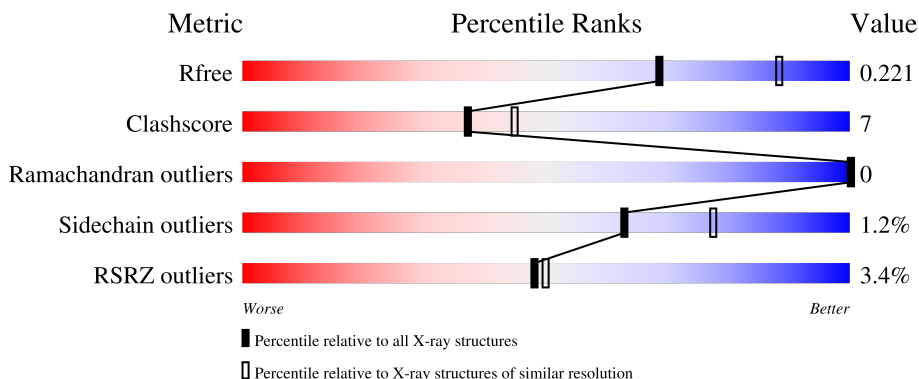
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.27 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	9078 (2.30-2.26)
Clashscore	190562	9802 (2.30-2.26)
Ramachandran outliers	187476	9690 (2.30-2.26)
Sidechain outliers	187428	9691 (2.30-2.26)
RSRZ outliers	180081	9085 (2.30-2.26)

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	230	3% 80% 11% 8%
1	B	230	77% 12% 12%
1	C	230	6% 77% 12% 9%
1	D	230	4% 76% 11% 12%
1	E	230	2% 75% 14% 10%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 8583 atoms, of which 64 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 Soluble acetylcholine receptor.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	211	Total	C	N	O	S	0	1	0
			1650	1043	273	326	8			
1	B	203	Total	C	N	O	S	0	0	0
			1567	997	254	309	7			
1	C	209	Total	C	N	O	S	0	1	0
			1597	1010	263	316	8			
1	D	203	Total	C	N	O	S	0	0	0
			1574	998	257	311	8			
1	E	207	Total	C	N	O	S	0	1	0
			1613	1020	266	319	8			

There are 60 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-8	ASP	-	expression tag	UNP Q8WSF8
A	-7	TYR	-	expression tag	UNP Q8WSF8
A	-6	LYS	-	expression tag	UNP Q8WSF8
A	-5	ASP	-	expression tag	UNP Q8WSF8
A	-4	ASP	-	expression tag	UNP Q8WSF8
A	-3	ASP	-	expression tag	UNP Q8WSF8
A	-2	ASP	-	expression tag	UNP Q8WSF8
A	-1	LYS	-	expression tag	UNP Q8WSF8
A	0	LEU	-	expression tag	UNP Q8WSF8
A	55	TRP	TYR	engineered mutation	UNP Q8WSF8
A	220	SER	-	expression tag	UNP Q8WSF8
A	221	ARG	-	expression tag	UNP Q8WSF8
B	-8	ASP	-	expression tag	UNP Q8WSF8
B	-7	TYR	-	expression tag	UNP Q8WSF8
B	-6	LYS	-	expression tag	UNP Q8WSF8
B	-5	ASP	-	expression tag	UNP Q8WSF8
B	-4	ASP	-	expression tag	UNP Q8WSF8
B	-3	ASP	-	expression tag	UNP Q8WSF8
B	-2	ASP	-	expression tag	UNP Q8WSF8

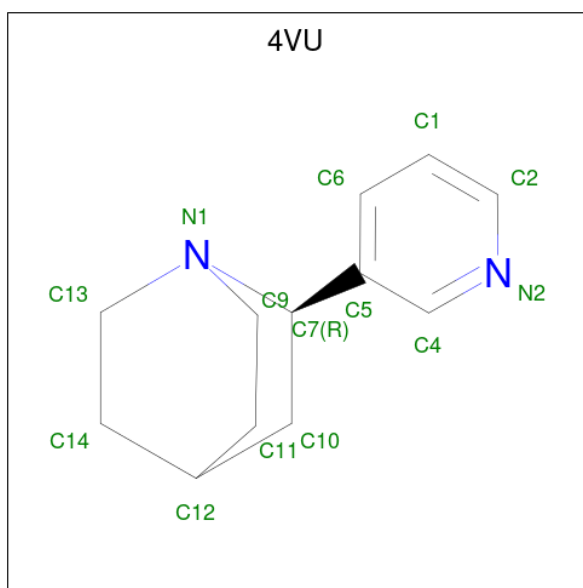
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Chain	Residue	Modelled	Actual	Comment	Reference
B	-1	LYS	-	expression tag	UNP Q8WSF8
B	0	LEU	-	expression tag	UNP Q8WSF8
B	55	TRP	TYR	engineered mutation	UNP Q8WSF8
B	220	SER	-	expression tag	UNP Q8WSF8
B	221	ARG	-	expression tag	UNP Q8WSF8
C	-8	ASP	-	expression tag	UNP Q8WSF8
C	-7	TYR	-	expression tag	UNP Q8WSF8
C	-6	LYS	-	expression tag	UNP Q8WSF8
C	-5	ASP	-	expression tag	UNP Q8WSF8
C	-4	ASP	-	expression tag	UNP Q8WSF8
C	-3	ASP	-	expression tag	UNP Q8WSF8
C	-2	ASP	-	expression tag	UNP Q8WSF8
C	-1	LYS	-	expression tag	UNP Q8WSF8
C	0	LEU	-	expression tag	UNP Q8WSF8
C	55	TRP	TYR	engineered mutation	UNP Q8WSF8
C	220	SER	-	expression tag	UNP Q8WSF8
C	221	ARG	-	expression tag	UNP Q8WSF8
D	-8	ASP	-	expression tag	UNP Q8WSF8
D	-7	TYR	-	expression tag	UNP Q8WSF8
D	-6	LYS	-	expression tag	UNP Q8WSF8
D	-5	ASP	-	expression tag	UNP Q8WSF8
D	-4	ASP	-	expression tag	UNP Q8WSF8
D	-3	ASP	-	expression tag	UNP Q8WSF8
D	-2	ASP	-	expression tag	UNP Q8WSF8
D	-1	LYS	-	expression tag	UNP Q8WSF8
D	0	LEU	-	expression tag	UNP Q8WSF8
D	55	TRP	TYR	engineered mutation	UNP Q8WSF8
D	220	SER	-	expression tag	UNP Q8WSF8
D	221	ARG	-	expression tag	UNP Q8WSF8
E	-8	ASP	-	expression tag	UNP Q8WSF8
E	-7	TYR	-	expression tag	UNP Q8WSF8
E	-6	LYS	-	expression tag	UNP Q8WSF8
E	-5	ASP	-	expression tag	UNP Q8WSF8
E	-4	ASP	-	expression tag	UNP Q8WSF8
E	-3	ASP	-	expression tag	UNP Q8WSF8
E	-2	ASP	-	expression tag	UNP Q8WSF8
E	-1	LYS	-	expression tag	UNP Q8WSF8
E	0	LEU	-	expression tag	UNP Q8WSF8
E	55	TRP	TYR	engineered mutation	UNP Q8WSF8
E	220	SER	-	expression tag	UNP Q8WSF8
E	221	ARG	-	expression tag	UNP Q8WSF8

- Molecule 2 is (2R)-2-(pyridin-3-yl)-1-azabicyclo[2.2.2]octane (CCD ID: 4VU) (formula:

$C_{12}H_{16}N_2$).



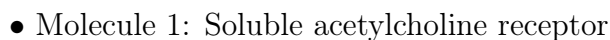
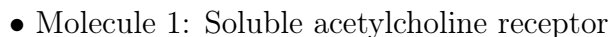
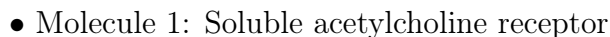
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	H	N	0	0
			30	12	16	2		
2	B	1	Total	C	H	N	0	0
			30	12	16	2		
2	C	1	Total	C	H	N	0	0
			30	12	16	2		
2	D	1	Total	C	H	N	0	0
			30	12	16	2		

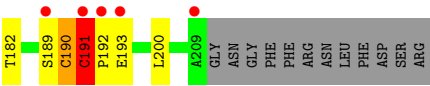
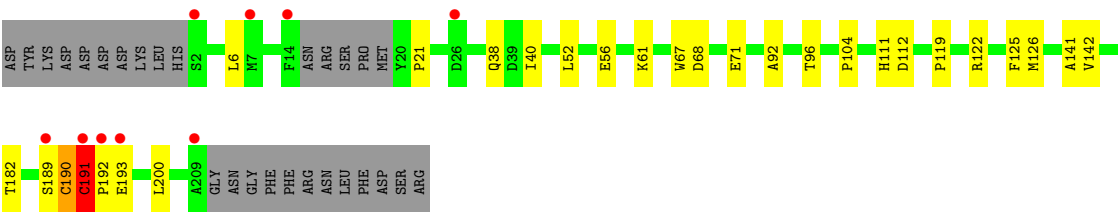
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	115	Total	O	0	0
			115	115		
3	B	91	Total	O	0	0
			91	91		
3	C	73	Total	O	0	0
			73	73		
3	D	81	Total	O	0	0
			81	81		
3	E	102	Total	O	0	0
			102	102		

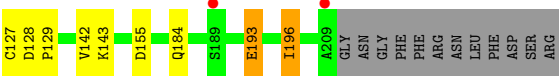
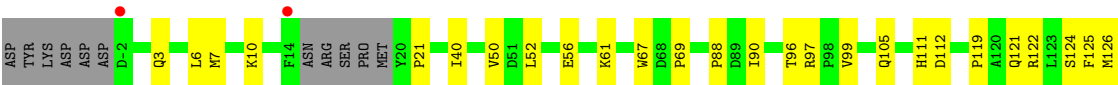
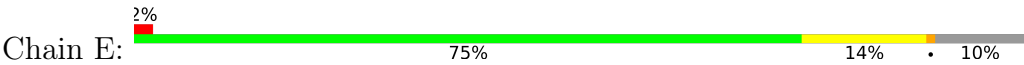
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- Molecule 1: Soluble acetylcholine receptor





● Molecule 1: Soluble acetylcholine receptor



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	163.74Å 84.40Å 119.66Å 90.00° 130.80° 90.00°	Depositor
Resolution (Å)	61.98 – 2.27 61.98 – 2.27	Depositor EDS
% Data completeness (in resolution range)	99.9 (61.98-2.27) 99.9 (61.98-2.27)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.69 (at 2.27Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, R_{free}	0.184 , 0.222 0.192 , 0.221	Depositor DCC
R_{free} test set	2896 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å ²)	32.6	Xtriage
Anisotropy	0.600	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 42.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.010 for h,-k,-h-l	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	8583	wwPDB-VP
Average B, all atoms (Å ²)	35.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.00% 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: 4VU

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	0.79	1/1692 (0.1%)	0.80	5/2312 (0.2%)
1	B	0.70	1/1606 (0.1%)	0.78	1/2199 (0.0%)
1	C	0.87	0/1637	0.94	10/2241 (0.4%)
1	D	0.75	0/1612	0.82	4/2205 (0.2%)
1	E	0.61	1/1651 (0.1%)	0.78	4/2258 (0.2%)
All	All	0.75	3/8198 (0.0%)	0.83	24/11215 (0.2%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	194	PRO	C-O	-6.19	1.16	1.23
1	A	198	VAL	C-O	-5.04	1.18	1.24
1	E	196	ILE	C-O	-5.02	1.19	1.24

The worst 5 of 24 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	191	CYS	N-CA-C	8.18	123.79	109.48
1	C	41	VAL	N-CA-C	6.45	117.23	110.72
1	D	190	CYS	N-CA-C	6.35	118.20	111.28
1	D	191	CYS	N-CA-C	6.33	118.43	108.55
1	A	191	CYS	N-CA-C	5.96	119.29	109.58

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	1650	0	1553	23	0
1	B	1567	0	1463	20	0
1	C	1597	0	1481	21	0
1	D	1574	0	1482	23	0
1	E	1613	0	1516	33	0
2	A	14	16	16	3	0
2	B	14	16	16	3	0
2	C	14	16	16	4	0
2	D	14	16	16	1	0
3	A	115	0	0	3	0
3	B	91	0	0	1	0
3	C	73	0	0	1	0
3	D	81	0	0	2	0
3	E	102	0	0	4	0
All	All	8519	64	7559	109	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 7.

The worst 5 of 109 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:E:7:MET:HA	1:E:7:MET:HE2	1.40	1.04
1:A:21:PRO:HB3	1:E:7:MET:HE3	1.41	1.01
1:C:155:ASP:OD1	1:C:183:ARG:NH2	1.94	0.98
1:E:155:ASP:HA	1:E:196:ILE:HD12	1.60	0.84
1:C:63:ASN:O	1:C:66:MET:HE2	1.84	0.77

There are no symmetry-related clashes.

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	208/230 (90%)	203 (98%)	5 (2%)	0	100	100
1	B	199/230 (86%)	195 (98%)	4 (2%)	0	100	100
1	C	206/230 (90%)	202 (98%)	4 (2%)	0	100	100
1	D	199/230 (86%)	193 (97%)	6 (3%)	0	100	100
1	E	204/230 (89%)	200 (98%)	4 (2%)	0	100	100
All	All	1016/1150 (88%)	993 (98%)	23 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	181/208 (87%)	180 (99%)	1 (1%)	78	87
1	B	170/208 (82%)	170 (100%)	0	100	100
1	C	170/208 (82%)	166 (98%)	4 (2%)	43	59
1	D	173/208 (83%)	170 (98%)	3 (2%)	53	70
1	E	176/208 (85%)	174 (99%)	2 (1%)	65	79
All	All	870/1040 (84%)	860 (99%)	10 (1%)	63	79

5 of 10 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	191	CYS
1	E	142	VAL
1	E	193	GLU
1	C	142	VAL
1	C	193	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	199	ASN
1	C	105	GLN
1	D	121	GLN
1	E	105	GLN
1	E	162	GLN

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](#)

4 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	4VU	B	301	-	16,16,16	0.83	1 (6%)	20,22,22	1.19	2 (10%)
2	4VU	C	301	-	16,16,16	1.85	3 (18%)	20,22,22	1.70	7 (35%)
2	4VU	A	301	-	16,16,16	0.83	1 (6%)	20,22,22	1.18	2 (10%)
2	4VU	D	301	-	16,16,16	1.73	3 (18%)	20,22,22	1.76	3 (15%)

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	4VU	B	301	-	-	4/4/22/22	0/4/3/3
2	4VU	C	301	-	-	0/4/22/22	0/4/3/3
2	4VU	A	301	-	-	4/4/22/22	0/4/3/3
2	4VU	D	301	-	-	0/4/22/22	0/4/3/3

The worst 5 of 8 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	D	301	4VU	C10-C7	-3.98	1.49	1.53
2	C	301	4VU	C5-C7	-3.76	1.46	1.51
2	C	301	4VU	C10-C7	-3.71	1.49	1.53
2	D	301	4VU	C6-C5	-2.25	1.35	1.39
2	D	301	4VU	C5-C7	-2.18	1.48	1.51

The worst 5 of 14 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	301	4VU	C11-C9-N1	-4.66	104.25	111.42
2	C	301	4VU	C1-C6-C5	-3.32	116.67	120.65
2	D	301	4VU	C14-C13-N1	-3.29	106.35	111.42
2	C	301	4VU	C11-C9-N1	-2.75	107.19	111.42
2	A	301	4VU	C11-C9-N1	-2.71	107.25	111.42

There are no chirality outliers.

5 of 8 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	301	4VU	C4-C5-C7-N1
2	B	301	4VU	C4-C5-C7-N1

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Mol	Chain	Res	Type	Atoms
2	A	301	4VU	C6-C5-C7-N1
2	B	301	4VU	C6-C5-C7-N1
2	A	301	4VU	C6-C5-C7-C10

There are no ring outliers.

4 monomers are involved in 11 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	301	4VU	3	0
2	C	301	4VU	4	0
2	A	301	4VU	3	0
2	D	301	4VU	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 [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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	211/230 (91%)	-0.04	7 (3%) 49 51	16, 29, 51, 67	1 (0%)
1	B	203/230 (88%)	0.01	1 (0%) 87 88	22, 32, 48, 60	0
1	C	209/230 (90%)	0.45	14 (6%) 24 25	17, 38, 64, 75	1 (0%)
1	D	203/230 (88%)	0.24	9 (4%) 39 40	23, 34, 54, 63	0
1	E	207/230 (90%)	0.09	4 (1%) 66 68	13, 32, 49, 62	1 (0%)
All	All	1033/1150 (89%)	0.15	35 (3%) 48 50	13, 33, 53, 75	3 (0%)

The worst 5 of 35 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	19	MET	3.9
1	A	-2	ASP	3.7
1	C	70	ASN	3.6
1	C	195	TYR	3.5
1	C	-2	ASP	3.2

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	4VU	C	301	14/14	0.86	0.12	38,55,65,66	0
2	4VU	A	301	14/14	0.88	0.10	32,39,48,50	0
2	4VU	D	301	14/14	0.90	0.10	37,47,56,57	0
2	4VU	B	301	14/14	0.94	0.07	26,38,47,50	0

6.5 Other polymers [i](#)

There are no such residues in this entry.