



Full wwPDB X-ray Structure Validation Report ⓘ

Apr 5, 2026 – 11:42 AM UTC

PDB ID : 1RM9 / pdb_00001rm9
Title : Probing the Role of Tryptophans in Aequorea Victoria Green Fluorescent Proteins with an Expanded Genetic Code
Authors : Budisa, N.; Pal, P.P.; Alefelder, S.; Birle, P.; Krywcun, T.; Rubini, M.; Wenger, W.; Bae, J.H.; Steiner, T.
Deposited on : 2003-11-27
Resolution : 2.90 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
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

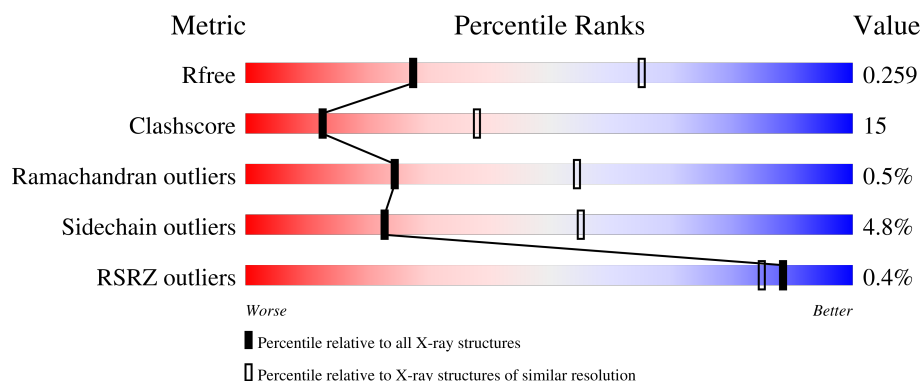
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.90 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	2481 (2.90-2.90)
Clashscore	190562	2690 (2.90-2.90)
Ramachandran outliers	187476	2623 (2.90-2.90)
Sidechain outliers	187428	2625 (2.90-2.90)
RSRZ outliers	180081	2481 (2.90-2.90)

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	236	 60% 33% • 5%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 1844 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 avermectin-sensitive chloride channel GluCl beta/cyan fluorescent protein fusion.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	225	Total	C	F	N	O	S	0	0	0
			1783	1137	2	302	337	5			

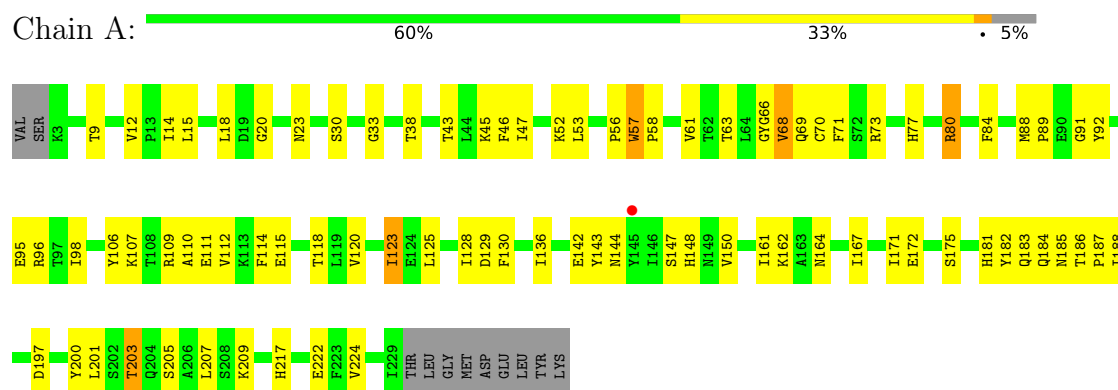
There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	66	4F3	THR	chromophore	UNP P42212
A	66	4F3	TRP	chromophore	UNP P42212
A	66	4F3	GLY	chromophore	UNP P42212
A	80	ARG	GLN	conflict	UNP P42212

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	61	Total	O	0	0
			61	61		

- Molecule 1: avermectin-sensitive chloride channel GluCl beta/cyan fluorescent protein fusion



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	51.06Å 62.51Å 69.47Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 2.90 30.00 – 2.90	Depositor EDS
% Data completeness (in resolution range)	96.5 (30.00-2.90) 96.4 (30.00-2.90)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.27 (at 2.88Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.207 , 0.268 0.193 , 0.259	Depositor DCC
R_{free} test set	544 reflections (10.38%)	wwPDB-VP
Wilson B-factor (Å ²)	31.5	Xtriage
Anisotropy	0.283	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 53.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	1844	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.82% 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](#)

Bond lengths and bond angles in the following residue types are not validated in this section: 4F3, 4FW

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	0.82	2/1780 (0.1%)	0.95	4/2405 (0.2%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	63	THR	C-N	-18.71	1.07	1.33
1	A	68	VAL	C-N	-6.63	1.24	1.33

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	197	ASP	N-CA-C	-6.05	102.73	110.53
1	A	68	VAL	N-CA-CB	5.95	121.61	111.50
1	A	200	TYR	N-CA-C	5.22	116.92	109.14
1	A	14	ILE	N-CA-C	5.18	115.36	108.11

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	1783	0	1707	53	0
2	A	61	0	0	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	1844	0	1707	53	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 15.

All (53) 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:45:LYS:HE2	1:A:47:ILE:HD11	1.64	0.79
1:A:111:GLU:HG2	1:A:188:ILE:HD11	1.69	0.73
1:A:203:THR:HG23	1:A:224:VAL:HG22	1.73	0.71
1:A:80:ARG:HD2	1:A:80:ARG:H	1.60	0.67
1:A:125:LEU:C	1:A:125:LEU:HD23	2.23	0.63
1:A:128:ILE:O	1:A:129:ASP:HB2	1.98	0.61
1:A:88:MET:HG3	1:A:89:PRO:HA	1.81	0.61
1:A:56:PRO:HD2	1:A:136:ILE:HG23	1.83	0.59
1:A:171:ILE:HD12	1:A:175:SER:HB3	1.84	0.58
1:A:107:LYS:HG3	2:A:262:HOH:O	2.04	0.58
1:A:136:ILE:HD12	1:A:136:ILE:N	2.19	0.58
1:A:162:LYS:HE3	1:A:184:GLN:HE21	1.69	0.56
1:A:12:VAL:HB	1:A:71:PHE:CZ	2.40	0.56
1:A:88:MET:SD	1:A:91:GLY:HA2	2.48	0.53
1:A:150:VAL:HB	1:A:201:LEU:HB2	1.90	0.53
1:A:98:ILE:HB	1:A:106:TYR:HB2	1.92	0.52
1:A:205:SER:OG	1:A:222:GLU:HG3	2.10	0.50
1:A:23:ASN:OD1	1:A:130:PHE:HB2	2.12	0.50
1:A:88:MET:HG3	1:A:114:PHE:HD2	1.77	0.50
1:A:20:GLY:HA2	1:A:125:LEU:O	2.12	0.49
1:A:148:HIS:CD2	1:A:167:ILE:HD13	2.47	0.49
1:A:18:LEU:C	1:A:18:LEU:HD23	2.38	0.49
1:A:70:CYS:HA	1:A:84:PHE:HB3	1.95	0.48
1:A:96:ARG:HA	1:A:182:TYR:O	2.13	0.48
1:A:46:PHE:O	1:A:217:HIS:HB2	2.13	0.48
1:A:148:HIS:HD2	1:A:167:ILE:HD13	1.78	0.48
1:A:95:GLU:HG2	1:A:109:ARG:HG3	1.95	0.48
1:A:77:HIS:HA	1:A:80:ARG:NH1	2.29	0.48
1:A:186:THR:HG22	1:A:187:PRO:HD2	1.97	0.47
1:A:161:ILE:CG1	1:A:185:ASN:HB2	2.46	0.46
1:A:110:ALA:HB2	1:A:123:ILE:HG23	1.96	0.46
1:A:70:CYS:HA	1:A:84:PHE:CB	2.45	0.46
1:A:171:ILE:HG22	1:A:172:GLU:N	2.31	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:57:4FW:HB3	1:A:58:PRO:HD3	1.97	0.46
1:A:12:VAL:HB	1:A:71:PHE:HZ	1.81	0.45
1:A:15:LEU:HG	1:A:118:THR:HG21	1.98	0.45
1:A:128:ILE:O	1:A:128:ILE:HG13	2.16	0.44
1:A:142:GLU:HB3	1:A:144:ASN:ND2	2.33	0.44
1:A:68:VAL:C	1:A:70:CYS:H	2.26	0.44
1:A:88:MET:HE1	1:A:92:TYR:CE2	2.53	0.43
1:A:148:HIS:CD2	1:A:167:ILE:HA	2.53	0.43
1:A:207:LEU:HD12	1:A:207:LEU:N	2.33	0.43
1:A:167:ILE:HG13	1:A:181:HIS:CE1	2.55	0.42
1:A:53:LEU:HD22	1:A:57:4FW:CE2	2.48	0.42
1:A:38:THR:O	1:A:73:ARG:HD3	2.19	0.42
1:A:53:LEU:HD22	1:A:57:4FW:CD2	2.49	0.42
1:A:71:PHE:HE1	2:A:243:HOH:O	2.03	0.41
1:A:61:VAL:N	2:A:255:HOH:O	2.54	0.41
1:A:143:TYR:CE2	1:A:209:LYS:HE2	2.56	0.41
1:A:115:GLU:CG	1:A:120:VAL:HG21	2.50	0.41
1:A:56:PRO:CD	1:A:136:ILE:HG23	2.49	0.41
1:A:33:GLY:HA3	1:A:43:THR:O	2.19	0.41
1:A:96:ARG:NH2	1:A:183:GLN:OE1	2.48	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	219/236 (93%)	207 (94%)	11 (5%)	1 (0%)	24 54

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	69	GLN

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	188/204 (92%)	179 (95%)	9 (5%)	23 55

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	9	THR
1	A	30	SER
1	A	52	LYS
1	A	80	ARG
1	A	112	VAL
1	A	123	ILE
1	A	147	SER
1	A	164	ASN
1	A	203	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	135	ASN
1	A	184	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](#)

2 non-standard protein/DNA/RNA residues 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
1	4F3	A	66	1	25,27,28	3.45	11 (44%)	26,39,41	1.96	7 (26%)
1	4FW	A	57	1	15,16,17	0.73	0	14,22,24	1.02	1 (7%)

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
1	4F3	A	66	1	-	2/12/15/16	0/3/3/3
1	4FW	A	57	1	-	2/5/6/8	0/2/2/2

All (11) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	66	4F3	C11-CA2	-11.04	1.39	1.50
1	A	66	4F3	C11-C7	-8.52	1.40	1.50
1	A	66	4F3	O3-C3	3.72	1.41	1.20
1	A	66	4F3	C6-N9	-3.52	1.32	1.37
1	A	66	4F3	CA2-C2	3.45	1.43	1.36
1	A	66	4F3	CA2-N2	-3.42	1.31	1.38
1	A	66	4F3	C1-N2	-3.36	1.27	1.32
1	A	66	4F3	C9-C22	3.23	1.44	1.37
1	A	66	4F3	C8-N9	-2.62	1.33	1.37
1	A	66	4F3	CA1-N1	2.45	1.54	1.47
1	A	66	4F3	C8-C7	2.20	1.40	1.36

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	66	4F3	O3-C3-CA3	-3.83	108.22	125.47
1	A	66	4F3	C1-CA1-N1	-3.70	103.17	109.78
1	A	66	4F3	CA1-C1-N3	3.60	128.94	124.69
1	A	66	4F3	C2-CA2-N2	-3.04	105.16	109.85
1	A	66	4F3	N3-C1-N2	-2.59	109.44	111.48
1	A	57	4FW	CZ3-CE3-CD2	-2.53	118.83	123.48
1	A	66	4F3	C3-CA3-N3	2.37	117.83	112.43

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	66	4F3	C5-C6-N9	-2.26	127.11	130.74

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	66	4F3	C7-C11-CA2-N2
1	A	66	4F3	C7-C11-CA2-C2
1	A	57	4FW	N-CA-CB-CG
1	A	57	4FW	C-CA-CB-CG

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	A	57	4FW	3	0

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

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](#)

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	A	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	A	63:THR	C	64:LEU	N	1.07

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	223/236 (94%)	-0.27	1 (0%) 88 85	11, 25, 37, 58	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	145	TYR	2.1

6.2 Non-standard residues in protein, DNA, RNA chains [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
1	4F3	A	66	25/26	0.89	0.12	34,36,40,49	0
1	4FW	A	57	15/16	0.96	0.07	14,16,19,21	0

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.