



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 02:34 PM UTC

PDB ID : 5KJ4 / pdb_00005kj4
Title : Crystal Structure of Mouse Protocadherin-15 EC9-10
Authors : Araya-Secchi, R.; Sotomayor, M.
Deposited on : 2016-06-17
Resolution : 3.35 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

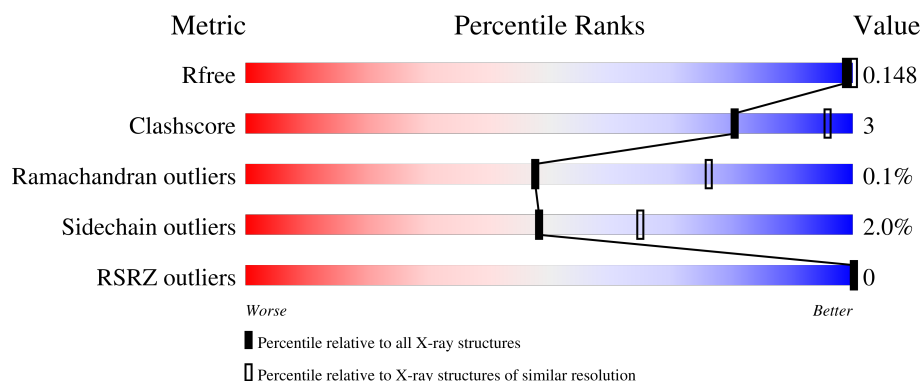
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.35 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	1099 (3.40-3.32)
Clashscore	190562	1116 (3.40-3.32)
Ramachandran outliers	187476	1101 (3.40-3.32)
Sidechain outliers	187428	1101 (3.40-3.32)
RSRZ outliers	180081	1099 (3.40-3.32)

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	234	91% 6% .
1	B	234	91% 7% .
1	C	234	88% 7% 5%
1	D	234	87% 8% 5%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 7023 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 Protocadherin-15.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	228	Total	C	N	O	S	0	0	0
			1771	1125	294	348	4			
1	B	228	Total	C	N	O	S	0	0	0
			1771	1125	294	348	4			
1	C	222	Total	C	N	O	S	0	0	0
			1722	1090	288	340	4			
1	D	222	Total	C	N	O	S	0	0	0
			1722	1090	288	340	4			

There are 32 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1124	LEU	-	expression tag	UNP Q99PJ1
A	1125	GLU	-	expression tag	UNP Q99PJ1
A	1126	HIS	-	expression tag	UNP Q99PJ1
A	1127	HIS	-	expression tag	UNP Q99PJ1
A	1128	HIS	-	expression tag	UNP Q99PJ1
A	1129	HIS	-	expression tag	UNP Q99PJ1
A	1130	HIS	-	expression tag	UNP Q99PJ1
A	1131	HIS	-	expression tag	UNP Q99PJ1
B	1124	LEU	-	expression tag	UNP Q99PJ1
B	1125	GLU	-	expression tag	UNP Q99PJ1
B	1126	HIS	-	expression tag	UNP Q99PJ1
B	1127	HIS	-	expression tag	UNP Q99PJ1
B	1128	HIS	-	expression tag	UNP Q99PJ1
B	1129	HIS	-	expression tag	UNP Q99PJ1
B	1130	HIS	-	expression tag	UNP Q99PJ1
B	1131	HIS	-	expression tag	UNP Q99PJ1
C	1124	LEU	-	expression tag	UNP Q99PJ1
C	1125	GLU	-	expression tag	UNP Q99PJ1
C	1126	HIS	-	expression tag	UNP Q99PJ1
C	1127	HIS	-	expression tag	UNP Q99PJ1
C	1128	HIS	-	expression tag	UNP Q99PJ1

Continued on next page...

Continued from previous page...

Chain	Residue	Modelled	Actual	Comment	Reference
C	1129	HIS	-	expression tag	UNP Q99PJ1
C	1130	HIS	-	expression tag	UNP Q99PJ1
C	1131	HIS	-	expression tag	UNP Q99PJ1
D	1124	LEU	-	expression tag	UNP Q99PJ1
D	1125	GLU	-	expression tag	UNP Q99PJ1
D	1126	HIS	-	expression tag	UNP Q99PJ1
D	1127	HIS	-	expression tag	UNP Q99PJ1
D	1128	HIS	-	expression tag	UNP Q99PJ1
D	1129	HIS	-	expression tag	UNP Q99PJ1
D	1130	HIS	-	expression tag	UNP Q99PJ1
D	1131	HIS	-	expression tag	UNP Q99PJ1

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	3	Total Ca 3 3	0	0
2	B	3	Total Ca 3 3	0	0
2	C	3	Total Ca 3 3	0	0
2	D	3	Total Ca 3 3	0	0

- Molecule 3 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	6	Total O 6 6	0	0
3	B	11	Total O 11 11	0	0
3	C	4	Total O 4 4	0	0
3	D	4	Total O 4 4	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: Protocadherin-15

Chain A:  91% 6% .



• Molecule 1: Protocadherin-15

Chain B:  91% 7% .



• Molecule 1: Protocadherin-15

Chain C:  88% 7% 5%



• Molecule 1: Protocadherin-15

Chain D:  87% 8% 5%



4 Data and refinement statistics

Property	Value	Source
Space group	P 31	Depositor
Cell constants a, b, c, α , β , γ	143.54Å 143.54Å 95.60Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	46.98 – 3.35 46.98 – 3.35	Depositor EDS
% Data completeness (in resolution range)	99.9 (46.98-3.35) 99.9 (46.98-3.35)	Depositor EDS
R_{merge}	0.26	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.80 (at 3.32Å)	Xtriage
Refinement program	REFMAC 5.8.0151	Depositor
R, R_{free}	0.158 , 0.196 0.127 , 0.148	Depositor DCC
R_{free} test set	1367 reflections (4.33%)	wwPDB-VP
Wilson B-factor (Å ²)	69.9	Xtriage
Anisotropy	0.060	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 46.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.027 for -h,-k,l 0.198 for h,-h-k,-l 0.027 for -k,-h,-l	Xtriage
Reported twinning fraction	0.258 for H, K, L 0.244 for -K, -H, -L 0.244 for -h,-k,l 0.254 for K, H, -L	Depositor
Outliers	0 of 31573 reflections	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	7023	wwPDB-VP
Average B, all atoms (Å ²)	78.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.97% 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: CA

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	0.72	0/1811	0.79	1/2479 (0.0%)
1	B	0.71	0/1811	0.75	0/2479
1	C	0.71	0/1759	0.75	0/2406
1	D	0.71	0/1759	0.74	0/2406
All	All	0.71	0/7140	0.76	1/9770 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	1122	VAL	CB-CA-C	6.87	117.55	111.71

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	1771	0	1749	13	0
1	B	1771	0	1749	6	0
1	C	1722	0	1700	9	0
1	D	1722	0	1700	12	0
2	A	3	0	0	0	0
2	B	3	0	0	0	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	C	3	0	0	0	0
2	D	3	0	0	0	0
3	A	6	0	0	0	0
3	B	11	0	0	1	0
3	C	4	0	0	0	0
3	D	4	0	0	1	0
All	All	7023	0	6898	36	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 3.

All (36) 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:937:MET:HG3	1:A:938:PRO:HD2	1.58	0.85
1:A:937:MET:CG	1:A:938:PRO:HD2	2.17	0.75
1:A:1064:VAL:HG13	1:D:1091:LEU:HD21	1.76	0.67
1:A:1064:VAL:CG1	1:D:1091:LEU:HD21	2.33	0.59
1:D:1106:THR:O	3:D:2101:HOH:O	2.17	0.59
1:A:937:MET:CG	1:A:938:PRO:CD	2.83	0.55
1:C:921:GLY:O	1:D:923:PRO:HD3	2.06	0.55
1:B:920:LYS:N	1:B:972:ASN:OD1	2.42	0.52
1:A:937:MET:HG2	1:A:938:PRO:CD	2.40	0.52
1:D:920:LYS:N	1:D:972:ASN:OD1	2.43	0.52
1:A:920:LYS:N	1:A:972:ASN:OD1	2.42	0.51
1:C:920:LYS:N	1:C:972:ASN:OD1	2.42	0.51
1:D:913:MET:HE3	1:D:1006:LEU:HB3	1.95	0.48
1:D:923:PRO:HA	1:D:968:VAL:HG12	1.97	0.47
1:B:913:MET:HE3	1:B:1006:LEU:HB3	1.96	0.47
1:B:923:PRO:HA	1:B:968:VAL:HG12	1.97	0.47
1:C:1056:GLU:HB2	1:C:1058:LYS:HG2	1.96	0.46
1:A:913:MET:HE3	1:A:1006:LEU:HB3	1.96	0.46
1:C:913:MET:HE3	1:C:1006:LEU:HB3	1.99	0.45
1:A:937:MET:HG2	1:A:938:PRO:N	2.32	0.45
1:C:921:GLY:O	1:D:923:PRO:CD	2.64	0.45
1:C:923:PRO:HA	1:C:968:VAL:HG12	1.98	0.45
1:A:923:PRO:HA	1:A:968:VAL:HG12	1.98	0.44
1:A:903:PRO:HD2	1:A:996:SER:HA	2.01	0.42
1:C:903:PRO:HD2	1:C:996:SER:HA	2.01	0.42
1:D:918:ALA:HB3	1:D:973:LEU:HD12	2.02	0.42
1:D:1091:LEU:HD23	1:D:1091:LEU:O	2.20	0.41

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:1056:GLU:H	1:C:1056:GLU:CD	2.28	0.41
1:D:903:PRO:HD2	1:D:996:SER:HA	2.01	0.41
1:A:1122:VAL:HG22	1:A:1123:PHE:HD1	1.86	0.41
1:B:903:PRO:HD2	1:B:996:SER:HA	2.01	0.41
1:B:984:VAL:HG21	3:B:2104:HOH:O	2.20	0.40
1:C:1072:SER:HB3	1:C:1073:PRO:HD2	2.03	0.40
1:A:913:MET:HE2	1:A:913:MET:HB3	2.00	0.40
1:B:918:ALA:HB3	1:B:973:LEU:HD12	2.03	0.40
1:D:1072:SER:HB3	1:D:1073:PRO:HD2	2.02	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	226/234 (97%)	214 (95%)	12 (5%)	0	100	100
1	B	226/234 (97%)	214 (95%)	11 (5%)	1 (0%)	30	58
1	C	220/234 (94%)	212 (96%)	8 (4%)	0	100	100
1	D	220/234 (94%)	210 (96%)	10 (4%)	0	100	100
All	All	892/936 (95%)	850 (95%)	41 (5%)	1 (0%)	48	76

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	1122	VAL

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	200/206 (97%)	196 (98%)	4 (2%)	48	65
1	B	200/206 (97%)	196 (98%)	4 (2%)	48	65
1	C	194/206 (94%)	190 (98%)	4 (2%)	47	64
1	D	194/206 (94%)	190 (98%)	4 (2%)	47	64
All	All	788/824 (96%)	772 (98%)	16 (2%)	48	65

All (16) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1043	ASN
1	A	1081	SER
1	A	1117	ASN
1	A	1122	VAL
1	B	978	THR
1	B	1002	ARG
1	B	1043	ASN
1	B	1117	ASN
1	C	898	MET
1	C	1043	ASN
1	C	1117	ASN
1	C	1119	HIS
1	D	978	THR
1	D	1043	ASN
1	D	1079	ARG
1	D	1117	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	1097	ASN
1	B	1044	GLN
1	B	1097	ASN
1	C	1097	ASN
1	D	1044	GLN
1	D	1097	ASN

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 12 ligands modelled in this entry, 12 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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	228/234 (97%)	-0.61	0 100 100	54, 76, 121, 132	0
1	B	228/234 (97%)	-0.67	0 100 100	56, 73, 98, 113	0
1	C	222/234 (94%)	-0.67	0 100 100	53, 76, 106, 118	0
1	D	222/234 (94%)	-0.65	0 100 100	55, 73, 99, 117	0
All	All	900/936 (96%)	-0.65	0 100 100	53, 75, 108, 132	0

There are no RSRZ outliers to report.

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	CA	A	2002	1/1	0.99	0.03	80,80,80,80	0
2	CA	A	2001	1/1	1.00	0.03	106,106,106,106	0
2	CA	A	2003	1/1	1.00	0.04	66,66,66,66	0
2	CA	B	2001	1/1	1.00	0.01	74,74,74,74	0

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	CA	B	2002	1/1	1.00	0.02	69,69,69,69	0
2	CA	B	2003	1/1	1.00	0.02	60,60,60,60	0
2	CA	C	2001	1/1	1.00	0.04	98,98,98,98	0
2	CA	C	2002	1/1	1.00	0.03	54,54,54,54	0
2	CA	C	2003	1/1	1.00	0.02	53,53,53,53	0
2	CA	D	2001	1/1	1.00	0.02	93,93,93,93	0
2	CA	D	2002	1/1	1.00	0.03	67,67,67,67	0
2	CA	D	2003	1/1	1.00	0.02	57,57,57,57	0

6.5 Other polymers [i](#)

There are no such residues in this entry.