



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 07:08 PM UTC

PDB ID : 3HPN / pdb_00003hpn
Title : Ligand recognition by A-class EPH receptors: crystal structures of the EPHA2 ligand-binding domain and the EPHA2/EPHRIN-A1 complex
Authors : Himanen, J.P.; Goldgur, Y.; Miao, H.; Myshkin, E.; Guo, H.; Buck, M.; Nguyen, M.; Rajashankar, K.R.; Wang, B.; Nikolov, D.B.
Deposited on : 2009-06-04
Resolution : 2.52 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
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

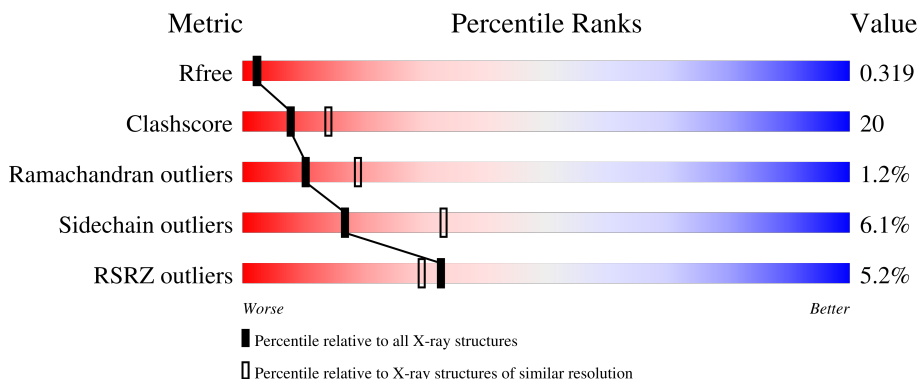
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.52 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	7383 (2.54-2.50)
Clashscore	190562	8079 (2.54-2.50)
Ramachandran outliers	187476	7944 (2.54-2.50)
Sidechain outliers	187428	7946 (2.54-2.50)
RSRZ outliers	180081	7387 (2.54-2.50)

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	174	7% 75% 21% .
1	B	174	5% 72% 25% ..
1	C	174	3% 73% 23% ..
1	D	174	5% 71% 24% 5%
1	E	174	3% 74% 22% 5%

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Mol	Chain	Length	Quality of chain
1	F	174	7% 75% 22%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 9426 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 Ephrin type-A receptor 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	174	Total	C	N	O	S	0	0	0
			1399	896	231	262	10			
1	B	174	Total	C	N	O	S	0	0	0
			1399	896	231	262	10			
1	C	174	Total	C	N	O	S	0	0	0
			1399	896	231	262	10			
1	D	174	Total	C	N	O	S	0	0	0
			1399	896	231	262	10			
1	E	174	Total	C	N	O	S	0	0	0
			1399	896	231	262	10			
1	F	174	Total	C	N	O	S	0	0	0
			1399	896	231	262	10			

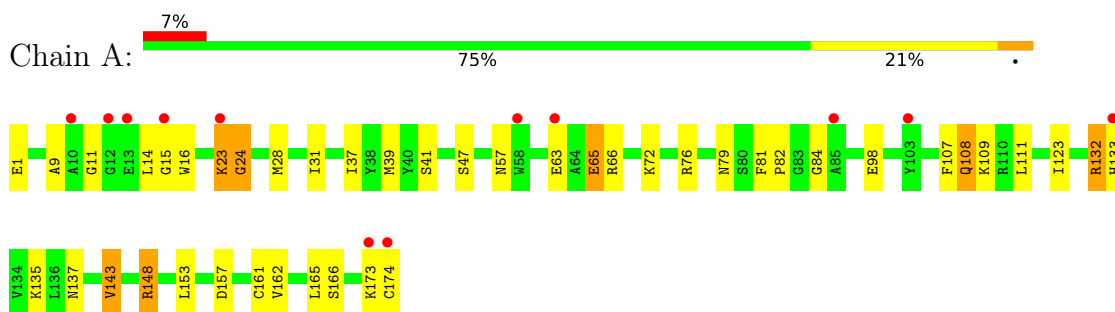
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	176	Total	O	0	0
			176	176		
2	B	190	Total	O	0	0
			190	190		
2	C	169	Total	O	0	0
			169	169		
2	D	170	Total	O	0	0
			170	170		
2	E	180	Total	O	0	0
			180	180		
2	F	147	Total	O	0	0
			147	147		

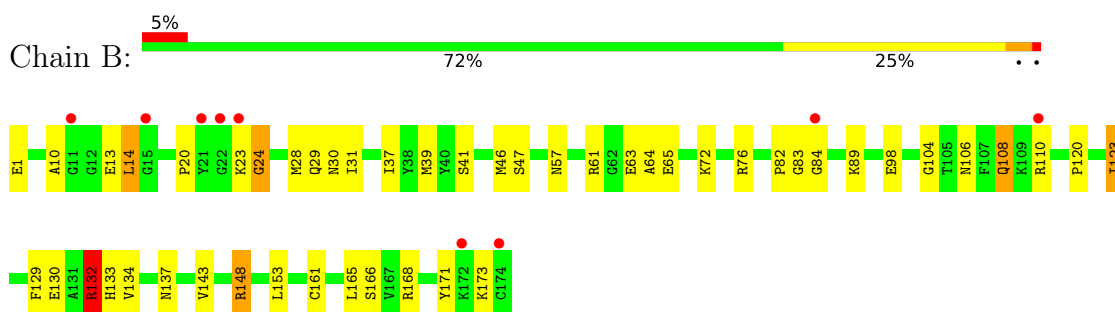
3 Residue-property plots [i](#)

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.

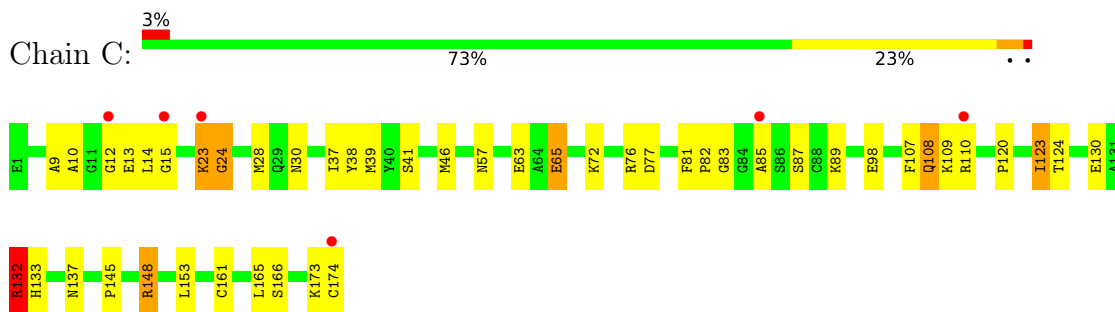
- Molecule 1: Ephrin type-A receptor 2



- Molecule 1: Ephrin type-A receptor 2



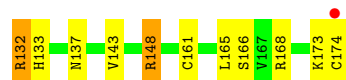
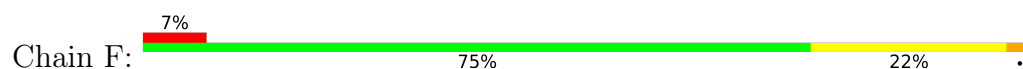
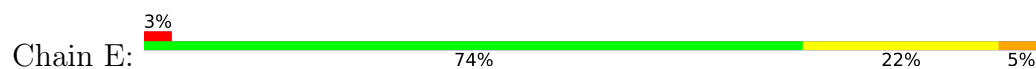
- Molecule 1: Ephrin type-A receptor 2



- Molecule 1: Ephrin type-A receptor 2



- Molecule 1: Ephrin type-A receptor 2



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	41.27Å 91.19Å 91.13Å 117.14° 97.27° 100.79°	Depositor
Resolution (Å)	30.00 – 2.52 30.00 – 2.52	Depositor EDS
% Data completeness (in resolution range)	96.8 (30.00-2.52) 96.8 (30.00-2.52)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.09	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.64 (at 2.53Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.232 , 0.307 0.242 , 0.319	Depositor DCC
R_{free} test set	1856 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å ²)	21.9	Xtriage
Anisotropy	0.400	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 29.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.075 for h,-h-k-l,k 0.075 for h,l,-h-k-l 0.010 for -h,-l,-k 0.015 for -h,h+k+l,-l 0.014 for -h,-k,h+k+l	Xtriage
F_o, F_c correlation	0.88	EDS
Total number of atoms	9426	wwPDB-VP
Average B, all atoms (Å ²)	2.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.03% 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	0.92	2/1433 (0.1%)	0.96	4/1940 (0.2%)
1	B	0.86	1/1433 (0.1%)	0.95	3/1940 (0.2%)
1	C	0.87	1/1433 (0.1%)	0.98	5/1940 (0.3%)
1	D	0.85	1/1433 (0.1%)	0.95	2/1940 (0.1%)
1	E	0.89	1/1433 (0.1%)	0.95	4/1940 (0.2%)
1	F	0.80	1/1433 (0.1%)	0.92	1/1940 (0.1%)
All	All	0.87	7/8598 (0.1%)	0.95	19/11640 (0.2%)

The worst 5 of 7 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	132	ARG	CZ-NH1	-8.29	1.21	1.32
1	C	132	ARG	CZ-NH1	-8.27	1.21	1.32
1	D	132	ARG	CZ-NH1	-7.86	1.21	1.32
1	E	132	ARG	CZ-NH1	-7.72	1.22	1.32
1	B	132	ARG	CZ-NH1	-7.29	1.22	1.32

The worst 5 of 19 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	132	ARG	NE-CZ-NH2	9.95	128.15	119.20
1	E	132	ARG	NE-CZ-NH2	9.93	128.14	119.20
1	D	132	ARG	NE-CZ-NH2	9.91	128.12	119.20
1	C	132	ARG	NE-CZ-NH2	9.49	127.75	119.20
1	B	132	ARG	NE-CZ-NH2	8.11	126.50	119.20

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	1399	0	1348	47	1
1	B	1399	0	1348	69	0
1	C	1399	0	1348	51	0
1	D	1399	0	1348	80	0
1	E	1399	0	1348	53	0
1	F	1399	0	1348	71	1
2	A	176	0	0	26	0
2	B	190	0	0	38	1
2	C	169	0	0	32	0
2	D	170	0	0	27	0
2	E	180	0	0	26	0
2	F	147	0	0	28	0
All	All	9426	0	8088	325	2

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 20.

The worst 5 of 325 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:D:29:GLN:O	1:F:110:ARG:CZ	1.64	1.46
1:B:23:LYS:HE2	2:B:377:HOH:O	1.19	1.35
1:D:14:LEU:CD1	1:F:106:ASN:OD1	1.74	1.33
1:C:133:HIS:HD2	2:C:182:HOH:O	1.04	1.28
1:B:61:ARG:HG3	2:B:801:HOH:O	1.32	1.28

All (2) 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)
2:B:440:HOH:O	2:B:954:HOH:O[1_455]	1.95	0.25
1:A:174:CYS:CA	1:F:174:CYS:O[1_456]	2.01	0.19

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	172/174 (99%)	158 (92%)	13 (8%)	1 (1%)	21	36
1	B	172/174 (99%)	161 (94%)	9 (5%)	2 (1%)	10	19
1	C	172/174 (99%)	159 (92%)	11 (6%)	2 (1%)	10	19
1	D	172/174 (99%)	157 (91%)	12 (7%)	3 (2%)	7	12
1	E	172/174 (99%)	158 (92%)	11 (6%)	3 (2%)	7	12
1	F	172/174 (99%)	159 (92%)	12 (7%)	1 (1%)	21	36
All	All	1032/1044 (99%)	952 (92%)	68 (7%)	12 (1%)	10	19

5 of 12 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	24	GLY
1	E	24	GLY
1	E	82	PRO
1	B	24	GLY
1	C	24	GLY

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	150/150 (100%)	140 (93%)	10 (7%)	15	29
1	B	150/150 (100%)	140 (93%)	10 (7%)	15	29
1	C	150/150 (100%)	142 (95%)	8 (5%)	20	39

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	D	150/150 (100%)	140 (93%)	10 (7%)	15	29
1	E	150/150 (100%)	141 (94%)	9 (6%)	17	34
1	F	150/150 (100%)	142 (95%)	8 (5%)	20	39
All	All	900/900 (100%)	845 (94%)	55 (6%)	17	33

5 of 55 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	14	LEU
1	D	143	VAL
1	F	148	ARG
1	F	65	GLU
1	D	37	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 43 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	108	GLN
1	E	133	HIS
1	E	29	GLN
1	E	79	ASN
1	F	33	ASN

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 [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](#)

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	174/174 (100%)	0.44	12 (6%) 23 20	2, 2, 3, 4	0
1	B	174/174 (100%)	0.43	9 (5%) 33 29	2, 2, 3, 4	0
1	C	174/174 (100%)	0.33	6 (3%) 48 44	2, 2, 2, 4	0
1	D	174/174 (100%)	0.42	8 (4%) 37 34	2, 2, 3, 4	0
1	E	174/174 (100%)	0.35	6 (3%) 48 44	2, 2, 2, 4	0
1	F	174/174 (100%)	0.68	13 (7%) 20 18	2, 2, 2, 3	0
All	All	1044/1044 (100%)	0.44	54 (5%) 33 29	2, 2, 3, 4	0

The worst 5 of 54 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	174	CYS	7.5
1	E	174	CYS	6.4
1	B	174	CYS	6.4
1	A	174	CYS	5.8
1	F	108	GLN	5.1

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.