WORLDWIDE wwPDB PROTEIN DATA BANK

wwPDB EM Validation Summary Report (i)

Dec 14, 2025 – 12:09 AM JST

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PDB ID	:	9WSX / pdb_00009wsx
EMDB ID	:	EMD-66209
Title	:	Cryo-EM structure of endomorphin-1-muOR-arrestin2-Fab30 complex
Authors	:	Zhang, H.; Wang, X.; Xi, K.; Shen, Q.; Xue, J.; Zhu, Y.; Yang, G.; Zhang, Y.
Deposited on	:	2025-09-15
Resolution	:	2.80 Å(reported)

1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:
ELECTRON MICROSCOPY

The reported resolution of this entry is 2.80 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	Percentile Ranks	Value
Clashscore		7
Ramachandran outliers		0
Sidechain outliers		0

Worse   *Better*

▌ Percentile relative to all structures
▯ Percentile relative to all EM structures
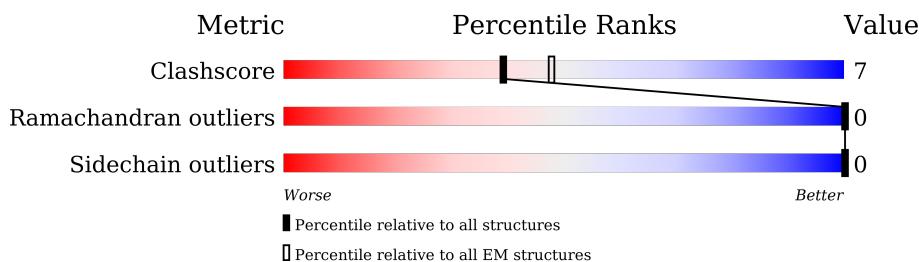
Metric	Whole archive (#Entries)	EM structures (#Entries)
Clashscore	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the 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%

Mol	Chain	Length	Quality of chain
1	R	386	54% 22% 24%
2	C	393	74% 16% 10%
3	H	236	77% 6% 17%
4	L	216	78% • 18%
5	P	5	60% 40%

2 Entry composition ⓘ

There are 6 unique types of molecules in this entry. The entry contains 7623 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, 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 Mu-type opioid receptor,Vasopressin V2 receptor.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	N	O	P	S		
1	R	292	2315	1512	363	408	6	26	0	0

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
R	3	GLY	-	expression tag	UNP P42866
R	4	PRO	-	expression tag	UNP P42866
R	5	MET	-	expression tag	UNP P42866
R	379	LEU	-	expression tag	UNP P30518
R	380	GLU	-	expression tag	UNP P30518
R	381	VAL	-	expression tag	UNP P30518
R	382	LEU	-	expression tag	UNP P30518
R	383	PHE	-	expression tag	UNP P30518
R	384	GLN	-	expression tag	UNP P30518

- Molecule 2 is a protein called Beta-arrestin-1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	C	353	2730	1745	464	511	10	0	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	169	GLU	ARG	conflict	UNP P17870
C	386	ALA	ILE	conflict	UNP P17870
C	387	ALA	VAL	conflict	UNP P17870
C	388	ALA	PHE	conflict	UNP P17870

- Molecule 3 is a protein called Fab30 heavy chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
3	H	196	1333	837	230	261	5	0	0

- Molecule 4 is a protein called Fab30 light chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
4	L	178	1198	750	202	242	4	0	0

- Molecule 5 is a protein called endomorphin-1.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
5	P	5	45	34	6	5	0	1

- Molecule 6 is water.

| Mol	Chain	Residues	Atoms		AltConf
			Total	O	
6	R	2	2	2	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. 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. 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: Mu-type opioid receptor,Vasopressin V2 receptor

Chain R:
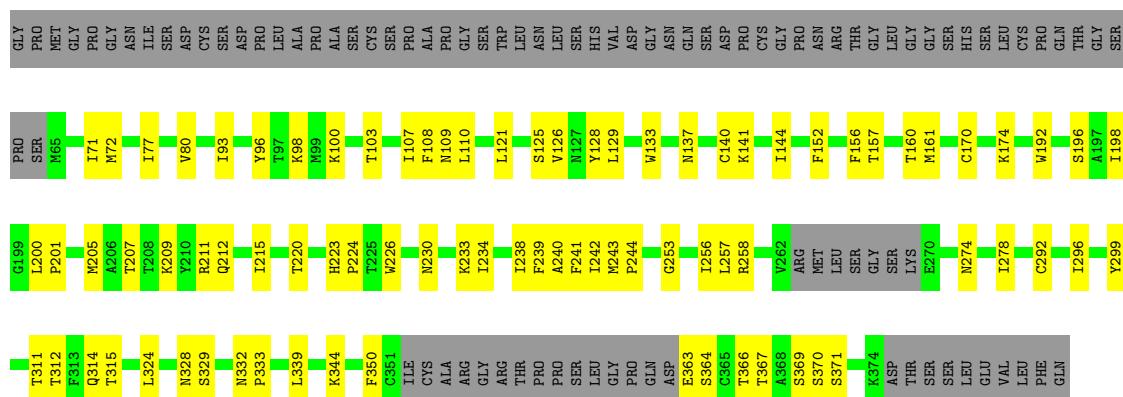
• Molecule 2: Beta-arrestin-1

Chain C:
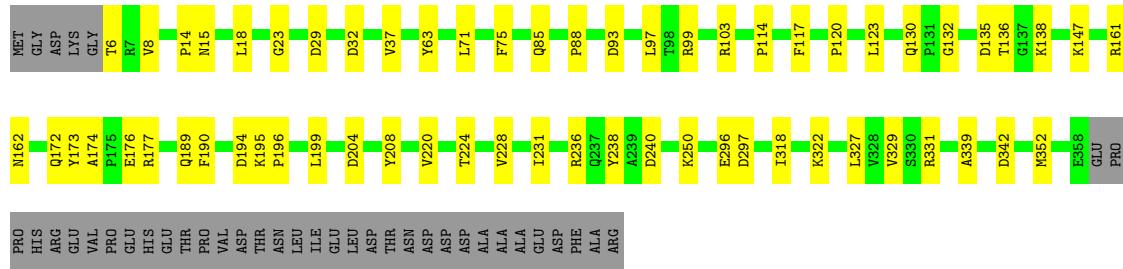
• Molecule 3: Fab30 heavy chain

Chain H:
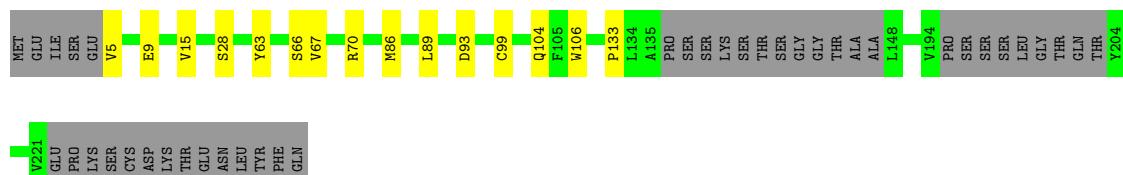
• Molecule 4: Fab30 light chain

Chain L:
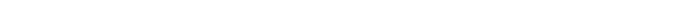
78%   •   18%
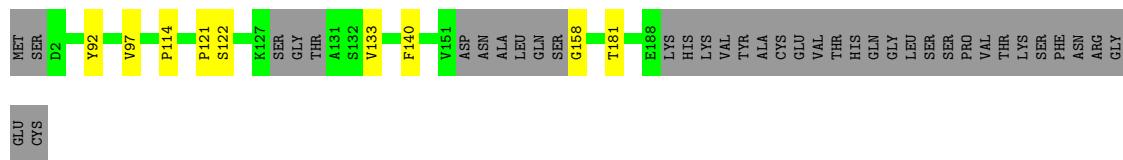
- Molecule 5: endomorphin-1

Chain P:

60%   40%

4 Experimental information ⓘ

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	206690	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	NONE	Depositor
Microscope	TFS KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose $(e^-/\text{Å}^2)$	52	Depositor
Minimum defocus (nm)	600	Depositor
Maximum defocus (nm)	2000	Depositor
Magnification	Not provided	
Image detector	FEI FALCON IV (4k x 4k)	Depositor

5   Model quality ⓘ

5.1   Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: SEP, TPO, NH2

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	R	0.20	0/2303	0.40	0/3137
2	C	0.10	0/2788	0.27	0/3792
3	H	0.09	0/1361	0.26	0/1868
4	L	0.09	0/1222	0.25	0/1678
5	P	0.42	0/48	0.93	0/66
All	All	0.14	0/7722	0.32	0/10541

There are no bond length outliers.

There are no bond angle outliers.

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	R	2315	0	2331	54	0
2	C	2730	0	2738	39	0
3	H	1333	0	1180	11	0
4	L	1198	0	1043	5	0
5	P	45	0	37	3	0
6	R	2	0	0	0	0
All	All	7623	0	7329	105	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 105 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:R:110:LEU:HD22	1:R:161:MET:HE1	1.63	0.80
1:R:128:TYR:HB2	5:P:4:PHE:HE2	1.49	0.78
1:R:243:MET:HG3	1:R:244:PRO:HD3	1.72	0.72
2:C:63:TYR:HB2	2:C:75:PHE:HB3	1.74	0.70
2:C:240:ASP:HB2	2:C:318:ILE:HB	1.76	0.68

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 PDB entries followed by that with respect to all EM entries.

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	R	280/386 (72%)	267 (95%)	13 (5%)	0	100	100
2	C	351/393 (89%)	336 (96%)	15 (4%)	0	100	100
3	H	190/236 (80%)	188 (99%)	2 (1%)	0	100	100
4	L	172/216 (80%)	166 (96%)	6 (4%)	0	100	100
5	P	3/5 (60%)	3 (100%)	0	0	100	100
All	All	996/1236 (81%)	960 (96%)	36 (4%)	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 PDB entries followed by that with respect to all EM entries.

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	R	250/336 (74%)	250 (100%)	0	100	100
2	C	299/347 (86%)	299 (100%)	0	100	100
3	H	126/199 (63%)	126 (100%)	0	100	100
4	L	115/191 (60%)	115 (100%)	0	100	100
5	P	4/4 (100%)	4 (100%)	0	100	100
All	All	794/1077 (74%)	794 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	R	183	ASN
1	R	342	ASN
2	C	85	GLN
3	H	165	ASN

5.3.3   RNA ⓘ

There are no RNA molecules in this entry.

5.4   Non-standard residues in protein, DNA, RNA chains ⓘ

6 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	SEP	R	371	1	8,9,10	1.55	1 (12%)	8,12,14	1.56	2 (25%)
1	SEP	R	369	1	8,9,10	1.54	1 (12%)	8,12,14	1.50	2 (25%)
1	SEP	R	364	1	8,9,10	1.54	1 (12%)	8,12,14	1.59	2 (25%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#|Z| > 2$	Counts	RMSZ	$\#|Z| > 2$
1	SEP	R	370	1	8,9,10	1.55	1 (12%)	8,12,14	1.56	2 (25%)
1	TPO	R	367	1	8,10,11	1.07	0	10,14,16	1.89	1 (10%)
1	TPO	R	366	1	8,10,11	1.10	0	10,14,16	1.88	1 (10%)

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	SEP	R	371	1	-	0/5/8/10	-
1	SEP	R	369	1	-	0/5/8/10	-
1	SEP	R	364	1	-	4/5/8/10	-
1	SEP	R	370	1	-	1/5/8/10	-
1	TPO	R	367	1	-	0/9/11/13	-
1	TPO	R	366	1	-	6/9/11/13	-

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	R	370	SEP	P-O1P	3.36	1.61	1.50
1	R	371	SEP	P-O1P	3.36	1.61	1.50
1	R	364	SEP	P-O1P	3.35	1.61	1.50
1	R	369	SEP	P-O1P	3.35	1.61	1.50

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	R	366	TPO	P-OG1-CB	-5.31	107.18	123.21
1	R	367	TPO	P-OG1-CB	-5.26	107.31	123.21
1	R	370	SEP	P-OG-CB	-2.94	110.18	118.30
1	R	371	SEP	P-OG-CB	-2.94	110.21	118.30
1	R	364	SEP	P-OG-CB	-2.88	110.36	118.30

There are no chirality outliers.

5 of 11 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	R	364	SEP	N-CA-CB-OG
1	R	364	SEP	CB-OG-P-O1P

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Mol	Chain	Res	Type	Atoms
1	R	364	SEP	CB-OG-P-O2P
1	R	364	SEP	CB-OG-P-O3P
1	R	366	TPO	N-CA-CB-OG1

There are no ring outliers.

No monomer is involved in short contacts.

5.5   Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6   Ligand geometry ⓘ

There are no ligands in this entry.

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.