Full wwPDB NMR Structure Validation Report (i)

Mar 12, 2026 – 06:17 PM UTC

PDB ID	:	1L0M / pdb_00001l0m
Title	:	Solution structure of Bacteriorhodopsin
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Deposited on	:	2002-02-11

This is a Full wwPDB NMR 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/NMRValidationReportHelp
with specific help available everywhere you see the (i) 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 (i)) were used in the production of this report:

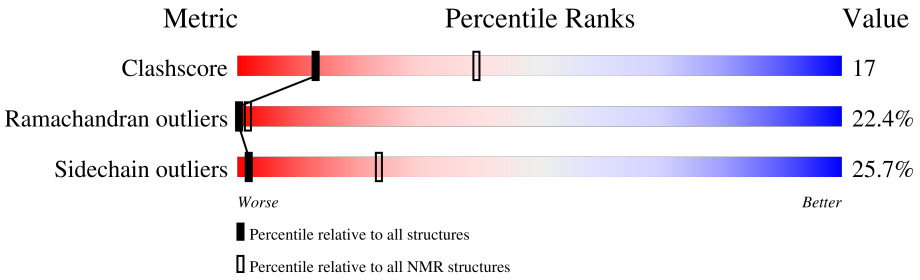
MolProbity	:	4-5-2 with Phenix2.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
wwPDB-RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
wwPDB-ShiftChecker	:	v1.2
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
SOLUTION NMR

The overall completeness of chemical shifts assignment was not calculated.

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)	NMR archive (#Entries)
Clashscore	229148	14424
Ramachandran outliers	224038	12848
Sidechain outliers	223484	12823

The table below summarises the geometric issues observed across the polymeric chains and their fit to the experimental data. The red, orange, yellow and green segments indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria. A cyan segment indicates the fraction of residues that are not part of the well-defined cores, and 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	A	212	43% 29% 15% 13%

2 Ensemble composition and analysis (i)

This entry contains 1 models. Identification of well-defined residues and clustering analysis are not possible.

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 3333 atoms, of which 1691 are hydrogens and 0 are deuteriums.

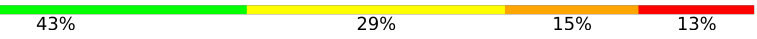
- Molecule 1 is a protein called Bacteriorhodopsin.

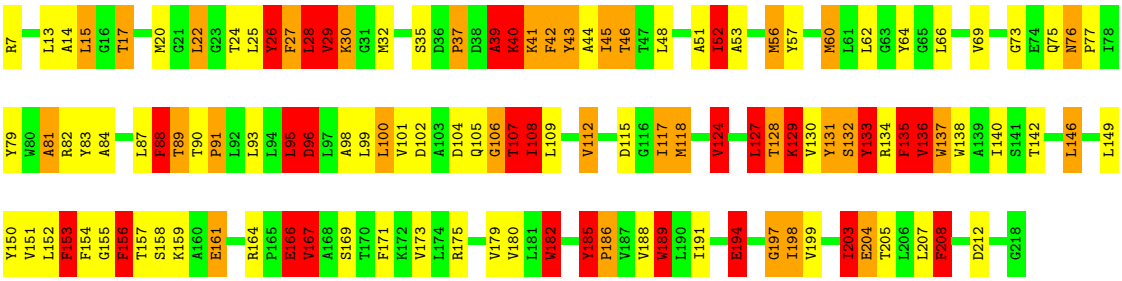
Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	212	3333	1104	1691	247	282	9	0

4 Residue-property plots (i)

These plots are provided for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-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 outliers are shown as green connectors. Residues which are classified as ill-defined in the NMR ensemble, are shown in cyan with an underline colour-coded according to the previous scheme. Residues which were present in the experimental sample, but not modelled in the final structure are shown in grey.

- Molecule 1: Bacteriorhodopsin

Chain A: 



5 Refinement protocol and experimental data overview

The models were refined using the following method: *refined using molecular dynamics.*

Of the ? calculated structures, 1 were deposited, based on the following criterion: *?.*

The following table shows the software used for structure solution, optimisation and refinement.

Software name	Classification	Version
SYBYL	structure solution	6.6
SYBYL	refinement	6.6

No chemical shift data was provided.

6 Model quality (i)

6.1 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 (average) 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	1.91	5/1688 (0.3%)	2.02	58/2309 (2.5%)
All	All	1.91	5/1688 (0.3%)	2.02	58/2309 (2.5%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	Chirality	Planarity
1	A	0	58
All	All	0	58

All bond outliers are listed below. They are sorted according to the Z-score.

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	182	TRP	NE1-CE2	51.80	1.94	1.37
1	A	182	TRP	CG-CD2	29.02	1.96	1.43
1	A	182	TRP	CD2-CE2	26.37	1.86	1.41
1	A	182	TRP	CD1-NE1	25.09	1.90	1.37
1	A	182	TRP	CG-CD1	14.55	1.73	1.36

All angle outliers are listed below. They are sorted according to the Z-score.

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	185	TYR	CG-CD2-CE2	-13.05	101.62	121.20
1	A	208	PHE	CA-CB-CG	12.88	126.69	113.80
1	A	134	ARG	CA-C-N	11.33	142.09	121.70
1	A	134	ARG	C-N-CA	11.33	142.09	121.70
1	A	133	TYR	CB-CA-C	10.94	124.67	111.22
1	A	95	LEU	CA-C-N	10.34	140.31	121.70
1	A	95	LEU	C-N-CA	10.34	140.31	121.70
1	A	185	TYR	CA-CB-CG	9.05	130.19	113.90
1	A	87	LEU	CA-C-N	8.97	137.84	121.70

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	87	LEU	C-N-CA	8.97	137.84	121.70
1	A	133	TYR	CA-CB-CG	7.93	128.17	113.90
1	A	88	PHE	CA-CB-CG	7.74	121.54	113.80
1	A	132	SER	CB-CA-C	7.70	124.72	110.10
1	A	182	TRP	CD2-CE2-CZ2	-7.66	114.74	122.40
1	A	52	ILE	CA-CB-CG2	7.63	123.47	110.50
1	A	27	PHE	CA-CB-CG	7.50	121.30	113.80
1	A	131	TYR	CA-C-N	7.17	134.61	121.70
1	A	131	TYR	C-N-CA	7.17	134.61	121.70
1	A	124	VAL	CA-CB-CG1	6.90	122.13	110.40
1	A	197	GLY	CA-C-N	6.90	134.12	121.70
1	A	197	GLY	C-N-CA	6.90	134.12	121.70
1	A	39	ALA	CA-C-N	6.85	134.04	121.70
1	A	39	ALA	C-N-CA	6.85	134.04	121.70
1	A	153	PHE	CA-CB-CG	6.73	120.53	113.80
1	A	42	PHE	CA-C-N	6.69	133.74	121.70
1	A	42	PHE	C-N-CA	6.69	133.74	121.70
1	A	151	VAL	N-CA-C	-6.49	106.23	111.81
1	A	41	LYS	N-CA-C	6.44	124.52	110.80
1	A	137	TRP	N-CA-C	-6.17	104.83	112.72
1	A	51	ALA	CA-C-N	6.15	133.03	121.97
1	A	51	ALA	C-N-CA	6.15	133.03	121.97
1	A	39	ALA	CB-CA-C	6.00	122.36	110.42
1	A	152	LEU	CA-C-N	5.85	130.93	121.98
1	A	152	LEU	C-N-CA	5.85	130.93	121.98
1	A	43	TYR	CA-C-N	-5.84	113.52	122.62
1	A	43	TYR	C-N-CA	-5.84	113.52	122.62
1	A	118	MET	N-CA-C	5.77	119.09	112.57
1	A	156	PHE	CB-CA-C	5.57	121.49	110.42
1	A	112	VAL	CA-C-N	5.55	126.25	120.03
1	A	112	VAL	C-N-CA	5.55	126.25	120.03
1	A	129	LYS	CB-CA-C	5.54	118.04	111.22
1	A	127	LEU	CA-C-O	-5.50	114.89	121.11
1	A	185	TYR	CB-CG-CD1	-5.35	112.78	120.80
1	A	37	PRO	N-CA-CB	5.33	106.62	102.73
1	A	40	LYS	CG-CD-CE	5.32	123.52	111.30
1	A	26	TYR	CA-CB-CG	5.31	123.45	113.90
1	A	117	ILE	CB-CA-C	5.24	119.89	111.29
1	A	194	GLU	CA-C-N	5.22	131.10	121.70
1	A	194	GLU	C-N-CA	5.22	131.10	121.70
1	A	167	VAL	CB-CA-C	5.22	119.85	111.29
1	A	29	VAL	N-CA-C	-5.21	106.06	111.58

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	156	PHE	O-C-N	-5.18	115.71	122.59
1	A	87	LEU	O-C-N	-5.13	116.19	122.25
1	A	182	TRP	NE1-CE2-CZ2	5.13	137.80	130.10
1	A	134	ARG	CA-CB-CG	5.12	124.35	114.10
1	A	44	ALA	N-CA-C	5.03	117.44	109.50
1	A	185	TYR	CE1-CZ-CE2	-5.02	110.26	120.30
1	A	134	ARG	N-CA-C	5.00	119.38	113.12

There are no chirality outliers.

All planar outliers are listed below.

Mol	Chain	Res	Type	Group
1	A	15	LEU	Peptide
1	A	20	MET	Peptide
1	A	22	LEU	Peptide
1	A	24	THR	Peptide
1	A	26	TYR	Sidechain
1	A	27	PHE	Sidechain,Peptide
1	A	28	LEU	Peptide
1	A	29	VAL	Peptide
1	A	30	LYS	Peptide
1	A	37	PRO	Peptide
1	A	40	LYS	Peptide
1	A	42	PHE	Sidechain
1	A	43	TYR	Sidechain,Peptide
1	A	45	ILE	Peptide
1	A	46	THR	Peptide
1	A	56	MET	Peptide
1	A	60	MET	Peptide
1	A	62	LEU	Peptide
1	A	64	TYR	Sidechain
1	A	77	PRO	Peptide
1	A	79	TYR	Sidechain,Peptide
1	A	81	ALA	Peptide
1	A	82	ARG	Sidechain
1	A	88	PHE	Sidechain
1	A	89	THR	Peptide
1	A	91	PRO	Peptide
1	A	96	ASP	Peptide
1	A	98	ALA	Peptide
1	A	100	LEU	Peptide
1	A	104	ASP	Peptide

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Mol	Chain	Res	Type	Group
1	A	106	GLY	Peptide
1	A	107	THR	Peptide
1	A	124	VAL	Peptide
1	A	130	VAL	Peptide
1	A	131	TYR	Sidechain
1	A	132	SER	Peptide
1	A	133	TYR	Sidechain
1	A	136	VAL	Peptide
1	A	142	THR	Peptide
1	A	150	TYR	Sidechain,Peptide
1	A	153	PHE	Peptide
1	A	154	PHE	Peptide
1	A	155	GLY	Peptide
1	A	156	PHE	Sidechain,Peptide
1	A	164	ARG	Sidechain,Peptide
1	A	166	GLU	Peptide
1	A	182	TRP	Peptide
1	A	185	TYR	Sidechain
1	A	189	TRP	Peptide
1	A	198	ILE	Peptide
1	A	203	ILE	Peptide
1	A	208	PHE	Sidechain

6.2 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 each 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 averaged over the ensemble.

Mol	Chain	Non-H	H(model)	H(added)	Clashes
1	A	1642	1691	1690	55
All	All	1642	1691	1690	55

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 17.

All clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:182:TRP:CD2	1:A:182:TRP:CE2	1.59	1.86
1:A:182:TRP:CD2	1:A:182:TRP:CG	1.53	1.96

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Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:182:TRP:NE1	1:A:182:TRP:CD1	1.37	1.90
1:A:182:TRP:CE2	1:A:182:TRP:NE1	1.34	1.94
1:A:182:TRP:CD2	1:A:185:TYR:CD2	1.24	2.26
1:A:182:TRP:CE2	1:A:185:TYR:CD2	1.21	2.28
1:A:182:TRP:CD1	1:A:185:TYR:CD2	1.20	2.27
1:A:182:TRP:CG	1:A:185:TYR:CD2	1.18	2.30
1:A:182:TRP:NE1	1:A:185:TYR:CD2	1.10	2.19
1:A:182:TRP:CG	1:A:185:TYR:HD2	1.05	1.66
1:A:182:TRP:CD2	1:A:185:TYR:HD2	1.02	1.62
1:A:182:TRP:CE2	1:A:185:TYR:CE2	0.94	2.55
1:A:182:TRP:CE2	1:A:185:TYR:HD2	0.89	1.80
1:A:182:TRP:CG	1:A:185:TYR:CB	0.77	2.68
1:A:182:TRP:CD1	1:A:185:TYR:HD2	0.75	1.80
1:A:182:TRP:NE1	1:A:185:TYR:CE2	0.74	2.56
1:A:39:ALA:HB3	1:A:40:LYS:HB3	0.72	1.60
1:A:182:TRP:CG	1:A:185:TYR:CG	0.72	2.76
1:A:182:TRP:NE1	1:A:185:TYR:HD2	0.72	1.82
1:A:182:TRP:HA	1:A:185:TYR:HB2	0.66	1.66
1:A:28:LEU:O	1:A:28:LEU:HD13	0.63	1.92
1:A:156:PHE:CD1	1:A:159:LYS:HG2	0.63	2.29
1:A:182:TRP:CG	1:A:185:TYR:HB2	0.60	2.30
1:A:129:LYS:HA	1:A:129:LYS:CE	0.58	2.29
1:A:52:ILE:HG23	1:A:88:PHE:CZ	0.56	2.35
1:A:56:MET:HG3	1:A:88:PHE:CZ	0.56	2.34
1:A:182:TRP:CD1	1:A:185:TYR:CG	0.54	2.93
1:A:156:PHE:HD2	1:A:171:PHE:CB	0.54	2.16
1:A:185:TYR:H	1:A:186:PRO:CD	0.52	2.17
1:A:106:GLY:C	1:A:107:THR:HG22	0.52	2.30
1:A:102:ASP:HB3	1:A:107:THR:HG21	0.51	1.81
1:A:182:TRP:CZ2	1:A:185:TYR:CE2	0.50	2.99
1:A:156:PHE:CD1	1:A:156:PHE:O	0.50	2.64
1:A:156:PHE:CD2	1:A:171:PHE:CB	0.49	2.96
1:A:156:PHE:CE2	1:A:167:VAL:HA	0.47	2.45
1:A:204:GLU:HG3	1:A:205:THR:N	0.45	2.26
1:A:135:PHE:CG	1:A:136:VAL:N	0.45	2.84
1:A:25:LEU:N	1:A:26:TYR:HA	0.44	2.28
1:A:182:TRP:CA	1:A:185:TYR:HB2	0.43	2.39
1:A:45:ILE:HG12	1:A:48:LEU:CB	0.43	2.43
1:A:135:PHE:C	1:A:135:PHE:CD1	0.43	2.97
1:A:81:ALA:C	1:A:83:TYR:H	0.43	2.21
1:A:107:THR:HG23	1:A:108:ILE:N	0.43	2.28
1:A:45:ILE:C	1:A:48:LEU:H	0.41	2.23

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Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:182:TRP:CG	1:A:185:TYR:HB3	0.41	2.46
1:A:75:GLN:O	1:A:76:ASN:CB	0.41	2.67
1:A:127:LEU:O	1:A:133:TYR:CG	0.41	2.74
1:A:128:THR:N	1:A:133:TYR:CD2	0.41	2.89
1:A:95:LEU:N	1:A:96:ASP:O	0.41	2.54
1:A:156:PHE:CE2	1:A:166:GLU:CB	0.41	3.04
1:A:45:ILE:HG12	1:A:48:LEU:HB3	0.41	1.93
1:A:52:ILE:HG23	1:A:88:PHE:CE2	0.40	2.51
1:A:189:TRP:CD2	1:A:189:TRP:N	0.40	2.89
1:A:149:LEU:O	1:A:153:PHE:N	0.40	2.54
1:A:156:PHE:CE1	1:A:159:LYS:HB2	0.40	2.50

6.3 Torsion angles (i)

6.3.1 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 PDB entries followed by that with respect to all NMR 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	A	210/212 (99%)	102 (49%)	61 (29%)	47 (22%)	0	2
All	All	210/212 (99%)	102 (49%)	61 (29%)	47 (22%)	0	2

All 47 Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type
1	A	14	ALA
1	A	17	THR
1	A	22	LEU
1	A	32	MET
1	A	39	ALA
1	A	40	LYS
1	A	41	LYS
1	A	52	ILE
1	A	53	ALA
1	A	66	LEU
1	A	73	GLY
1	A	76	ASN

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Mol	Chain	Res	Type
1	A	84	ALA
1	A	90	THR
1	A	91	PRO
1	A	95	LEU
1	A	96	ASP
1	A	101	VAL
1	A	105	GLN
1	A	107	THR
1	A	108	ILE
1	A	115	ASP
1	A	117	ILE
1	A	124	VAL
1	A	135	PHE
1	A	136	VAL
1	A	146	LEU
1	A	156	PHE
1	A	157	THR
1	A	158	SER
1	A	161	GLU
1	A	166	GLU
1	A	167	VAL
1	A	173	VAL
1	A	179	VAL
1	A	180	VAL
1	A	185	TYR
1	A	186	PRO
1	A	188	VAL
1	A	191	ILE
1	A	194	GLU
1	A	197	GLY
1	A	198	ILE
1	A	199	VAL
1	A	203	ILE
1	A	204	GLU
1	A	208	PHE

6.3.2 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 PDB entries followed by that with respect to all NMR 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	A	171/171 (100%)	127 (74%)	44 (26%)	2 23
All	All	171/171 (100%)	127 (74%)	44 (26%)	2 23

All 44 residues with a non-rotameric sidechain are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type
1	A	7	ARG
1	A	13	LEU
1	A	15	LEU
1	A	17	THR
1	A	26	TYR
1	A	28	LEU
1	A	29	VAL
1	A	30	LYS
1	A	35	SER
1	A	40	LYS
1	A	46	THR
1	A	57	TYR
1	A	60	MET
1	A	69	VAL
1	A	89	THR
1	A	93	LEU
1	A	95	LEU
1	A	99	LEU
1	A	100	LEU
1	A	108	ILE
1	A	109	LEU
1	A	112	VAL
1	A	118	MET
1	A	127	LEU
1	A	128	THR
1	A	129	LYS
1	A	135	PHE
1	A	137	TRP
1	A	138	TRP
1	A	140	ILE
1	A	146	LEU
1	A	161	GLU
1	A	166	GLU
1	A	167	VAL
1	A	169	SER
1	A	175	ARG

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Mol	Chain	Res	Type
1	A	182	TRP
1	A	185	TYR
1	A	189	TRP
1	A	194	GLU
1	A	203	ILE
1	A	207	LEU
1	A	208	PHE
1	A	212	ASP

6.3.3 RNA (i)

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

6.5 Carbohydrates (i)

There are no oligosaccharides in this entry.

6.6 Ligand geometry (i)

There are no ligands in this entry.

6.7 Other polymers (i)

There are no such molecules in this entry.

6.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

7 Chemical shift validation

No chemical shift data were provided