



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 12:49 PM UTC

PDB ID : 4ALY / pdb_00004aly
Title : Borrelia burgdorferi outer surface lipoprotein BBA64
Authors : Brangulis, K.; Tars, K.; Petrovskis, I.; Kazaks, A.; Ranka, R.; Baumanis, V.
Deposited on : 2012-03-06
Resolution : 2.40 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

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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

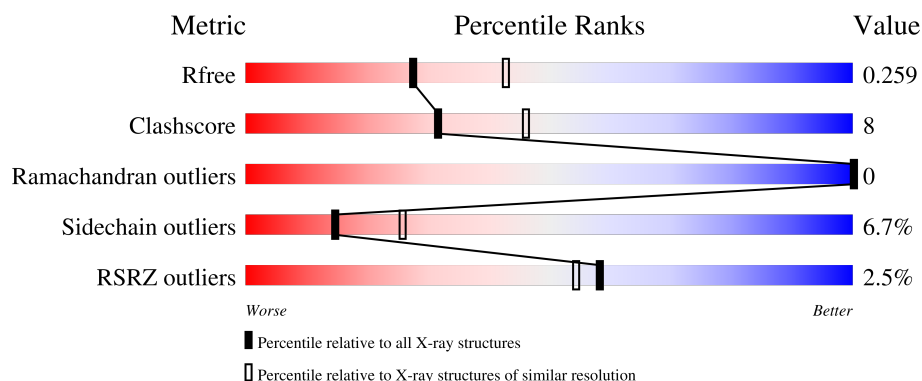
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

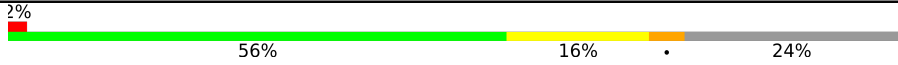
The reported resolution of this entry is 2.40 Å.

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	4912 (2.40-2.40)
Clashscore	190562	5391 (2.40-2.40)
Ramachandran outliers	187476	5320 (2.40-2.40)
Sidechain outliers	187428	5321 (2.40-2.40)
RSRZ outliers	180081	4916 (2.40-2.40)

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	279	
1	B	279	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	SO4	A	1303	-	-	X	-

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 3370 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.

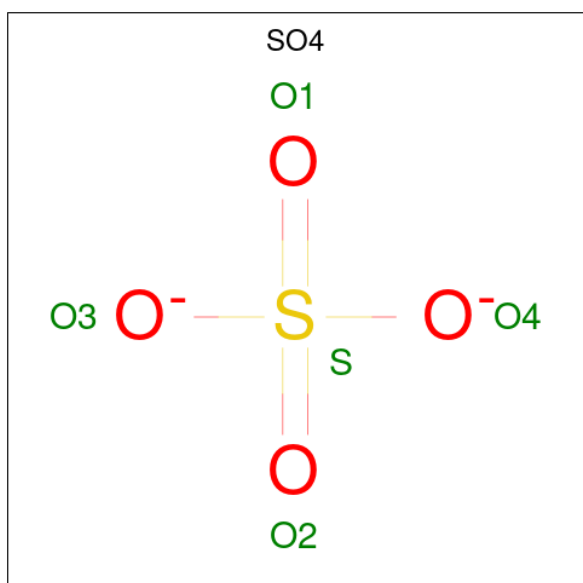
- Molecule 1 is a protein called P35 ANTIGEN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	211	Total	C	N	O	S	0	0	0
			1714	1075	292	343	4			
1	B	187	Total	C	N	O	S	0	0	0
			1517	949	256	308	4			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	24	GLY	-	expression tag	UNP P70848
A	25	ALA	-	expression tag	UNP P70848
A	26	MET	-	expression tag	UNP P70848
B	24	GLY	-	expression tag	UNP P70848
B	25	ALA	-	expression tag	UNP P70848
B	26	MET	-	expression tag	UNP P70848

- Molecule 2 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	O	S	0	0
			5	4	1		
2	A	1	Total	O	S	0	0
			5	4	1		
2	B	1	Total	O	S	0	0
			5	4	1		
2	B	1	Total	O	S	0	0
			5	4	1		
2	B	1	Total	O	S	0	0
			5	4	1		

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	66	Total	O	0	0
			66	66		
3	B	48	Total	O	0	0
			48	48		

4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	49.15Å 70.14Å 186.19Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	93.09 – 2.40 93.09 – 2.40	Depositor EDS
% Data completeness (in resolution range)	97.4 (93.09-2.40) 97.4 (93.09-2.40)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.77 (at 2.39Å)	Xtriage
Refinement program	REFMAC 5.6.0117	Depositor
R, R_{free}	0.213 , 0.261 0.213 , 0.259	Depositor DCC
R_{free} test set	1292 reflections (5.10%)	wwPDB-VP
Wilson B-factor (Å ²)	25.8	Xtriage
Anisotropy	0.039	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 30.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	3370	wwPDB-VP
Average B, all atoms (Å ²)	28.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.70% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: SO4

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	1.20	1/1738 (0.1%)	1.35	10/2344 (0.4%)
1	B	1.24	1/1537 (0.1%)	1.33	6/2071 (0.3%)
All	All	1.22	2/3275 (0.1%)	1.34	16/4415 (0.4%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	275	ASN	CA-CB	5.22	1.57	1.53
1	A	149	HIS	CG-CD2	5.19	1.41	1.35

All (16) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	155	ARG	CG-CD-NE	-7.19	96.18	112.00
1	A	266	LYS	N-CA-C	-6.82	103.92	111.36
1	B	155	ARG	NE-CZ-NH2	-6.58	113.28	119.20
1	B	169	ILE	N-CA-C	-6.45	104.22	110.42
1	B	292	ASN	N-CA-C	6.26	119.39	111.69
1	B	135	LYS	CB-CA-C	-5.92	100.46	110.64
1	A	155	ARG	NE-CZ-NH2	-5.72	114.06	119.20
1	A	196	ARG	CB-CG-CD	5.45	123.84	111.30
1	B	289	ASP	N-CA-C	5.37	117.13	111.28
1	A	222	ASN	N-CA-CB	-5.36	100.71	109.56
1	A	259	ASP	N-CA-CB	5.30	118.71	110.44
1	A	121	GLU	CA-C-N	5.17	125.17	120.21
1	A	121	GLU	C-N-CA	5.17	125.17	120.21
1	B	204	MET	N-CA-C	5.07	117.47	111.33
1	A	162	LEU	N-CA-C	-5.03	105.62	112.26
1	A	191	GLU	CA-CB-CG	5.02	124.15	114.10

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	1714	0	1705	36	0
1	B	1517	0	1483	18	0
2	A	10	0	0	2	0
2	B	15	0	0	1	1
3	A	66	0	0	4	1
3	B	48	0	0	0	0
All	All	3370	0	3188	52	1

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 8.

All (52) 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:102:ILE:HD13	1:A:229:LEU:HD21	1.45	0.96
1:A:272:ARG:HH11	1:A:272:ARG:HG2	1.45	0.81
1:B:191:GLU:HA	1:B:195:ASN:HD22	1.50	0.76
1:A:222:ASN:HD21	1:A:224:PRO:HB2	1.50	0.74
1:A:253:GLU:HB3	3:A:2060:HOH:O	1.92	0.70
1:A:282:ASN:O	1:A:286:ILE:HG13	1.93	0.69
1:B:272:ARG:HG3	2:B:1298:SO4:O2	1.94	0.67
1:A:97:LYS:HE2	3:A:2001:HOH:O	1.95	0.67
1:B:191:GLU:HA	1:B:195:ASN:ND2	2.09	0.66
1:A:272:ARG:HG2	1:A:272:ARG:NH1	2.13	0.64
1:A:190:LYS:NZ	1:A:195:ASN:HD21	1.97	0.63
1:A:102:ILE:CD1	1:A:229:LEU:HD21	2.24	0.62
1:B:148:SER:O	1:B:155:ARG:NH2	2.33	0.61
1:A:102:ILE:HD13	1:A:229:LEU:CD2	2.27	0.61
1:A:196:ARG:HD3	1:A:283:ILE:HD13	1.82	0.60
1:A:107:GLU:O	1:A:111:GLN:HG2	2.01	0.59
1:A:229:LEU:HD23	1:A:229:LEU:C	2.28	0.58

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:190:LYS:NZ	1:B:195:ASN:HD21	2.02	0.57
1:A:95:VAL:O	1:A:99:ILE:HG12	2.07	0.55
1:A:148:SER:O	1:A:155:ARG:NH2	2.40	0.55
1:B:178:LYS:HE2	1:B:254:TYR:OH	2.08	0.54
1:A:97:LYS:CE	3:A:2001:HOH:O	2.55	0.54
1:B:111:GLN:HG2	1:B:115:MET:HE2	1.90	0.54
1:A:229:LEU:HD23	1:A:230:TYR:N	2.23	0.53
1:A:167:GLY:HA2	1:B:167:GLY:HA2	1.90	0.53
1:B:282:ASN:O	1:B:286:ILE:HG13	2.09	0.53
1:A:249:ASP:O	1:A:253:GLU:HG3	2.09	0.52
1:A:92:ASP:HA	1:A:95:VAL:HB	1.91	0.52
1:B:252:ASP:O	1:B:256:THR:HB	2.10	0.52
1:B:259:ASP:C	1:B:259:ASP:OD1	2.52	0.52
1:A:272:ARG:NH1	2:A:1303:SO4:O1	2.42	0.51
1:A:102:ILE:CD1	1:A:229:LEU:CD2	2.87	0.51
1:B:156:ARG:HD2	1:B:156:ARG:C	2.35	0.50
1:A:272:ARG:NH1	2:A:1303:SO4:S	2.85	0.50
1:B:190:LYS:HZ2	1:B:195:ASN:HD21	1.59	0.50
1:A:236:LEU:HD13	1:A:290:LEU:HD13	1.94	0.49
1:B:168:LYS:HE2	1:B:248:ASP:OD1	2.13	0.48
1:A:179:LEU:HD13	3:A:2045:HOH:O	2.14	0.48
1:A:222:ASN:ND2	1:A:225:ASN:H	2.12	0.48
1:A:254:TYR:CZ	1:A:261:GLN:HG2	2.49	0.47
1:A:196:ARG:HG2	1:A:243:TRP:CE3	2.49	0.47
1:A:190:LYS:HZ2	1:A:195:ASN:HD21	1.64	0.45
1:A:222:ASN:OD1	1:A:224:PRO:HD2	2.17	0.45
1:A:166:GLU:OE1	1:B:126:PHE:HA	2.17	0.44
1:A:190:LYS:HZ3	1:A:195:ASN:HD21	1.65	0.44
1:A:263:ASP:CG	1:A:266:LYS:HG3	2.43	0.43
1:B:254:TYR:CZ	1:B:261:GLN:HG2	2.52	0.43
1:A:236:LEU:HD13	1:A:290:LEU:CD1	2.49	0.43
1:A:194:ILE:HA	1:A:198:PHE:HB3	1.99	0.42
1:A:168:LYS:HE3	1:A:168:LYS:HB2	1.45	0.41
1:B:215:LYS:HB3	1:B:215:LYS:HE2	1.57	0.41
1:B:194:ILE:HA	1:B:198:PHE:HB3	2.03	0.41

All (1) 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:1300:SO4:O2	3:A:2038:HOH:O[1_455]	2.15	0.05

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	209/279 (75%)	198 (95%)	11 (5%)	0	100	100
1	B	183/279 (66%)	177 (97%)	6 (3%)	0	100	100
All	All	392/558 (70%)	375 (96%)	17 (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 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	197/252 (78%)	177 (90%)	20 (10%)	7	11
1	B	174/252 (69%)	169 (97%)	5 (3%)	37	60
All	All	371/504 (74%)	346 (93%)	25 (7%)	15	26

All (25) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	94	GLU
1	A	97	LYS
1	A	99	ILE
1	A	142	SER
1	A	153	GLU
1	A	164	PHE
1	A	183	SER
1	A	223	LYS

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Mol	Chain	Res	Type
1	A	229	LEU
1	A	234	GLU
1	A	236	LEU
1	A	238	SER
1	A	245	LYS
1	A	256	THR
1	A	259	ASP
1	A	260	LEU
1	A	270	THR
1	A	272	ARG
1	A	274	LYS
1	A	302	GLN
1	B	229	LEU
1	B	253	GLU
1	B	256	THR
1	B	259	ASP
1	B	272	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	149	HIS
1	A	171	ASN
1	A	195	ASN
1	A	213	ASN
1	A	222	ASN
1	A	292	ASN
1	B	195	ASN
1	B	213	ASN
1	B	255	ASN
1	B	292	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 [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

5 ligands 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	$\# Z > 2$
2	SO4	A	1304	-	4,4,4	0.57	0	6,6,6	0.23	0
2	SO4	B	1299	-	4,4,4	0.59	0	6,6,6	0.30	0
2	SO4	B	1298	-	4,4,4	0.39	0	6,6,6	0.70	0
2	SO4	B	1300	-	4,4,4	0.36	0	6,6,6	0.75	0
2	SO4	A	1303	-	4,4,4	0.25	0	6,6,6	0.84	0

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.

3 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	1298	SO4	1	0
2	B	1300	SO4	0	1
2	A	1303	SO4	2	0

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

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	211/279 (75%)	-0.15	5 (2%) 59 55	12, 26, 51, 64	0
1	B	187/279 (67%)	-0.04	5 (2%) 56 52	11, 24, 53, 65	0
All	All	398/558 (71%)	-0.10	10 (2%) 58 54	11, 25, 53, 65	0

All (10) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	225	ASN	3.1
1	A	140	ALA	2.8
1	A	92	ASP	2.6
1	B	228	THR	2.5
1	A	94	GLU	2.4
1	B	288	LEU	2.2
1	A	229	LEU	2.2
1	B	297	ILE	2.2
1	A	222	ASN	2.1
1	B	231	ASN	2.0

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($\text{\AA}^2$)	Q<0.9
2	SO4	B	1300	5/5	0.85	0.15	54,55,68,69	0
2	SO4	B	1299	5/5	0.87	0.15	61,66,66,67	0
2	SO4	A	1304	5/5	0.90	0.16	60,64,74,75	0
2	SO4	B	1298	5/5	0.98	0.05	30,32,34,37	0
2	SO4	A	1303	5/5	0.99	0.05	24,25,28,28	0

6.5 Other polymers [i](#)

There are no such residues in this entry.