Full wwPDB X-ray Structure Validation Report (i)

Oct 24, 2023 – 08:51 PM EDT

PDB ID	:	3APT
Title	:	properties and crystal structure of methylenetetrahydrofolate reductase from Thermus thermophilus HB8
Authors	:	Yamada, K.
Deposited on	:	2010-10-20
Resolution	:	1.85 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 (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:

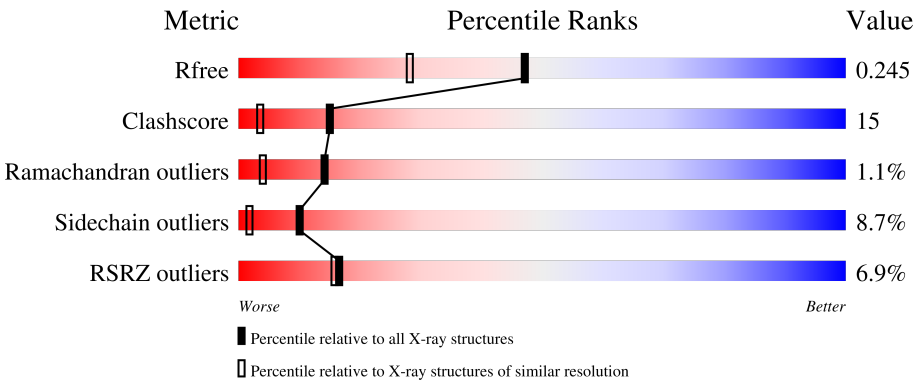
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.85 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}	130704	2469 (1.86-1.86)
Clashscore	141614	2625 (1.86-1.86)
Ramachandran outliers	138981	2592 (1.86-1.86)
Sidechain outliers	138945	2592 (1.86-1.86)
RSRZ outliers	127900	2436 (1.86-1.86)

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 <=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	310	6% 72% 18% • • 6%
1	B	310	7% 66% 17% 5% • 11%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 4962 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 Methylenetetrahydrofolate reductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	292	2307	1472	423	407	5	0	0	0
			Total	C	N	O	S			
1	B	275	2175	1391	395	385	4	0	0	0

There are 28 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	297	ALA	-	expression tag	UNP Q5SLG6
A	298	LYS	-	expression tag	UNP Q5SLG6
A	299	LEU	-	expression tag	UNP Q5SLG6
A	300	ALA	-	expression tag	UNP Q5SLG6
A	301	ALA	-	expression tag	UNP Q5SLG6
A	302	ALA	-	expression tag	UNP Q5SLG6
A	303	LEU	-	expression tag	UNP Q5SLG6
A	304	GLU	-	expression tag	UNP Q5SLG6
A	305	HIS	-	expression tag	UNP Q5SLG6
A	306	HIS	-	expression tag	UNP Q5SLG6
A	307	HIS	-	expression tag	UNP Q5SLG6
A	308	HIS	-	expression tag	UNP Q5SLG6
A	309	HIS	-	expression tag	UNP Q5SLG6
A	310	HIS	-	expression tag	UNP Q5SLG6
B	297	ALA	-	expression tag	UNP Q5SLG6
B	298	LYS	-	expression tag	UNP Q5SLG6
B	299	LEU	-	expression tag	UNP Q5SLG6
B	300	ALA	-	expression tag	UNP Q5SLG6
B	301	ALA	-	expression tag	UNP Q5SLG6
B	302	ALA	-	expression tag	UNP Q5SLG6
B	303	LEU	-	expression tag	UNP Q5SLG6
B	304	GLU	-	expression tag	UNP Q5SLG6
B	305	HIS	-	expression tag	UNP Q5SLG6
B	306	HIS	-	expression tag	UNP Q5SLG6
B	307	HIS	-	expression tag	UNP Q5SLG6

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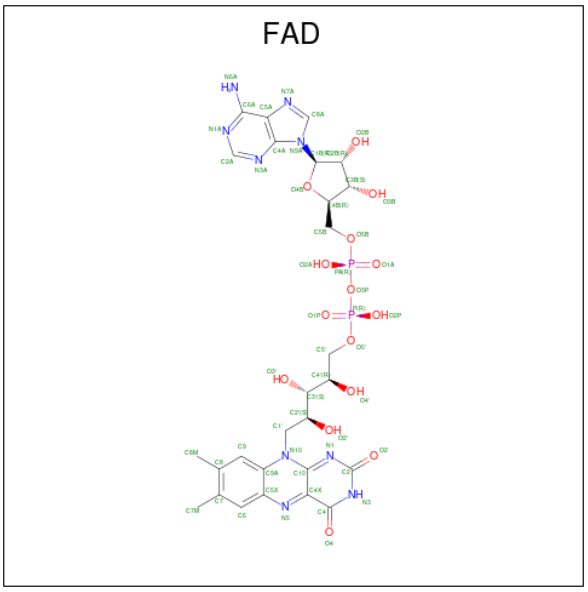
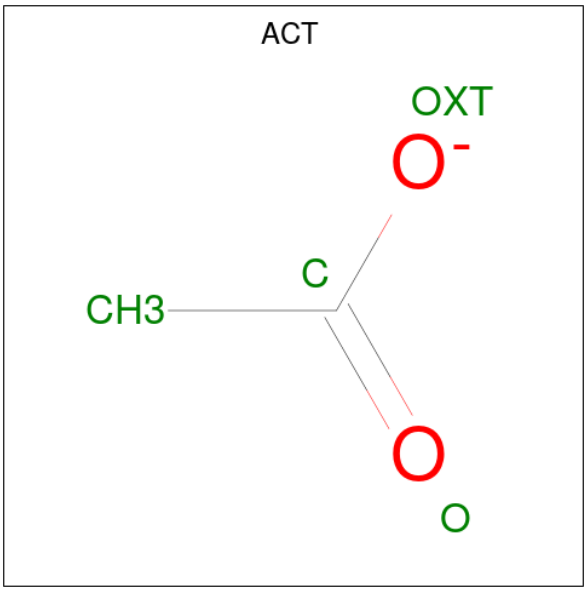
Chain	Residue	Modelled	Actual	Comment	Reference
B	308	HIS	-	expression tag	UNP Q5SLG6
B	309	HIS	-	expression tag	UNP Q5SLG6
B	310	HIS	-	expression tag	UNP Q5SLG6

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (three-letter code: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
2	A	1	53	27	9	15	2	0	0

- Molecule 3 is ACETATE ION (three-letter code: ACT) (formula: $C_2H_3O_2$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	B	1	4	2	2	0	0

- Molecule 4 is water.

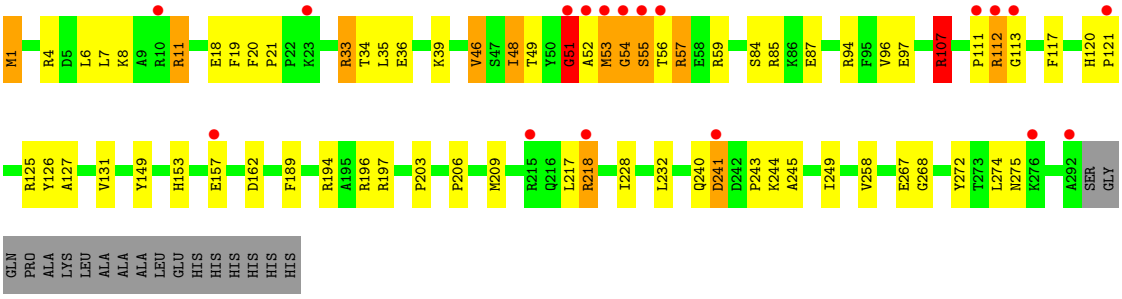
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	244	244	244	0	0
			Total	O		
4	B	179	179	179	0	0

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.

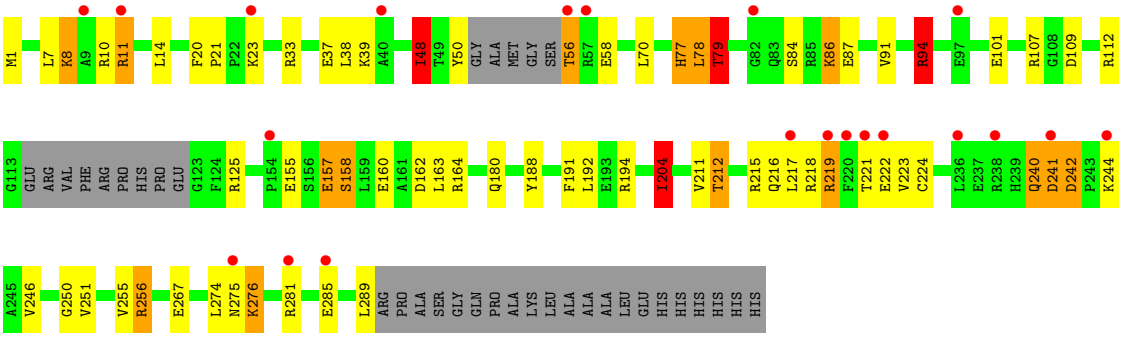
• Molecule 1: Methylenetetrahydrofolate reductase

Chain A:



• Molecule 1: Methylenetetrahydrofolate reductase

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	43.92Å 89.67Å 160.72Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.95 – 1.85 19.95 – 1.85	Depositor EDS
% Data completeness (in resolution range)	99.6 (19.95-1.85) 99.6 (19.95-1.85)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	5.02 (at 1.85Å)	Xtriage
Refinement program	REFMAC 5.5.0102	Depositor
R, R_{free}	0.203 , 0.252 0.198 , 0.245	Depositor DCC
R_{free} test set	2796 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å^2)	32.4	Xtriage
Anisotropy	0.020	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 50.2	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	4962	wwPDB-VP
Average B, all atoms (Å^2)	35.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.64% of the height of the origin peak. No significant pseudotranslation is detected.*

[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ 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: FAD, ACT

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	1.16	7/2362 (0.3%)	1.18	12/3192 (0.4%)
1	B	1.04	0/2223	1.05	8/3001 (0.3%)
All	All	1.10	7/4585 (0.2%)	1.12	20/6193 (0.3%)

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 outliers	#Planarity outliers
1	A	0	1
1	B	2	0
All	All	2	1

All (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	194	ARG	CD-NE	-6.32	1.35	1.46
1	A	267	GLU	CG-CD	6.17	1.61	1.51
1	A	46	VAL	CB-CG2	5.84	1.65	1.52
1	A	189	PHE	CD2-CE2	5.59	1.50	1.39
1	A	131	VAL	CB-CG1	5.45	1.64	1.52
1	A	258	VAL	CB-CG2	5.40	1.64	1.52
1	A	127	ALA	CA-CB	5.27	1.63	1.52

All (20) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	194	ARG	NE-CZ-NH2	-20.24	110.18	120.30
1	A	107	ARG	NE-CZ-NH1	12.04	126.32	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	33	ARG	NE-CZ-NH1	10.67	125.63	120.30
1	A	194	ARG	NE-CZ-NH1	9.80	125.20	120.30
1	A	194	ARG	CG-CD-NE	-7.97	95.07	111.80
1	B	33	ARG	NE-CZ-NH2	-7.49	116.55	120.30
1	A	196	ARG	NE-CZ-NH2	7.24	123.92	120.30
1	A	197	ARG	NE-CZ-NH2	-6.60	117.00	120.30
1	B	79	THR	CB-CA-C	-6.49	94.07	111.60
1	A	196	ARG	NE-CZ-NH1	-6.48	117.06	120.30
1	B	48	ILE	CG1-CB-CG2	6.39	125.45	111.40
1	A	197	ARG	NE-CZ-NH1	6.25	123.42	120.30
1	A	96	VAL	CG1-CB-CG2	6.14	120.72	110.90
1	B	78	LEU	CA-CB-CG	5.89	128.84	115.30
1	B	157	GLU	N-CA-C	5.79	126.64	111.00
1	A	107	ARG	NE-CZ-NH2	-5.75	117.42	120.30
1	A	54	GLY	N-CA-C	-5.44	99.51	113.10
1	B	204	ILE	CA-CB-CG2	5.42	121.74	110.90
1	A	94	ARG	NE-CZ-NH1	5.40	123.00	120.30
1	B	94	ARG	NE-CZ-NH1	5.32	122.96	120.30

All (2) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
1	B	48	ILE	CB
1	B	204	ILE	CB

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	51	GLY	Peptide

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	2307	0	2324	67	0
1	B	2175	0	2195	70	0
2	A	53	0	31	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	4	0	3	0	0
4	A	244	0	0	8	0
4	B	179	0	0	11	0
All	All	4962	0	4553	137	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 15.

All (137) 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:11:ARG:HH21	1:A:11:ARG:CG	1.69	1.04
1:A:33:ARG:HH11	1:A:33:ARG:HG3	1.26	1.01
1:A:11:ARG:HG2	1:A:11:ARG:NH2	1.57	0.99
1:B:86:LYS:O	1:B:86:LYS:HD3	1.62	0.97
1:A:55:SER:HB2	1:A:56:THR:C	1.92	0.89
1:B:191:PHE:HE2	1:B:204:ILE:CD1	1.87	0.87
1:B:157:GLU:O	4:B:576:HOH:O	1.91	0.87
1:A:57:ARG:HG2	4:A:426:HOH:O	1.75	0.86
1:B:212:THR:HG22	1:B:215:ARG:NH2	1.89	0.86
1:A:57:ARG:HH11	1:A:57:ARG:HB3	1.39	0.86
1:B:77:HIS:HD2	1:B:109:ASP:OD2	1.59	0.86
1:B:157:GLU:O	1:B:158:SER:HB3	1.77	0.84
1:B:215:ARG:HH11	1:B:219:ARG:NH2	1.76	0.84
1:B:21:PRO:HB3	1:B:48:ILE:HD11	1.58	0.83
1:B:215:ARG:NH1	1:B:219:ARG:HH22	1.77	0.83
1:B:256:ARG:NH1	4:B:579:HOH:O	2.12	0.83
1:B:215:ARG:NH1	1:B:219:ARG:NH2	2.27	0.81
1:A:112:ARG:HH11	1:A:112:ARG:HG2	1.45	0.81
1:A:55:SER:CB	1:A:56:THR:C	2.50	0.79
1:A:11:ARG:HH21	1:A:11:ARG:HG2	0.75	0.78
1:B:11:ARG:HG3	4:B:440:HOH:O	1.83	0.78
1:A:20:PHE:H	1:A:275:ASN:HD21	1.33	0.77
1:B:157:GLU:OE2	1:B:162:ASP:OD1	2.02	0.76
1:B:241:ASP:O	1:B:242:ASP:HB2	1.87	0.75
1:B:275:ASN:N	1:B:276:LYS:HB3	2.01	0.75
1:B:1:MET:HE3	4:B:492:HOH:O	1.85	0.75
1:B:212:THR:CG2	1:B:215:ARG:HH21	1.99	0.75
1:B:162:ASP:HB3	4:B:360:HOH:O	1.87	0.74
1:B:274:LEU:C	1:B:276:LYS:HB3	2.10	0.72
1:A:33:ARG:HH11	1:A:33:ARG:CG	2.01	0.70

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:55:SER:HB2	1:A:57:ARG:N	2.05	0.70
1:B:275:ASN:N	1:B:276:LYS:CB	2.54	0.69
1:B:94:ARG:HG2	1:B:94:ARG:HH11	1.57	0.69
1:B:275:ASN:HB3	1:B:276:LYS:HB2	1.74	0.68
1:B:215:ARG:HH11	1:B:219:ARG:HH22	1.36	0.68
1:A:244:LYS:O	4:A:568:HOH:O	2.11	0.68
1:B:191:PHE:CE2	1:B:204:ILE:HD11	2.30	0.67
1:B:191:PHE:HE2	1:B:204:ILE:HD11	1.58	0.67
1:B:191:PHE:CE2	1:B:204:ILE:CD1	2.75	0.67
1:B:160:GLU:OE1	1:B:164:ARG:NE	2.19	0.67
1:A:36:GLU:O	1:A:39:LYS:HG2	1.95	0.67
1:A:1:MET:HE3	4:A:513:HOH:O	1.95	0.66
1:A:218:ARG:CG	1:A:218:ARG:HH11	2.09	0.66
1:B:79:THR:CG2	1:B:107:ARG:O	2.44	0.66
1:A:21:PRO:HA	1:A:48:ILE:HD11	1.76	0.66
1:B:275:ASN:CA	1:B:276:LYS:HB2	2.27	0.65
1:B:274:LEU:HB3	1:B:276:LYS:HD3	1.79	0.64
1:B:212:THR:HG22	1:B:215:ARG:HH21	1.55	0.62
1:B:21:PRO:HB3	1:B:48:ILE:CD1	2.31	0.61
1:B:215:ARG:HD2	1:B:219:ARG:HH12	1.66	0.60
1:A:55:SER:HB3	1:A:56:THR:CA	2.32	0.60
1:B:215:ARG:HG2	1:B:219:ARG:NH1	2.16	0.60
1:B:251:VAL:O	1:B:255:VAL:HG23	2.00	0.60
1:B:275:ASN:CA	1:B:276:LYS:CB	2.80	0.60
1:A:153:HIS:HE1	2:A:311:FAD:O1P	1.84	0.59
1:B:275:ASN:CB	1:B:276:LYS:HB2	2.34	0.58
1:B:157:GLU:O	1:B:158:SER:CB	2.51	0.57
1:A:8:LYS:HE3	4:A:509:HOH:O	2.02	0.57
1:A:55:SER:HB3	1:A:56:THR:C	2.25	0.56
1:A:112:ARG:HD3	1:A:113:GLY:N	2.20	0.56
1:B:212:THR:CG2	1:B:215:ARG:NH2	2.60	0.56
1:A:149:TYR:CE1	1:A:153:HIS:CE1	2.94	0.56
1:B:241:ASP:O	1:B:242:ASP:CB	2.54	0.56
1:A:245:ALA:O	1:A:249:ILE:HG12	2.05	0.55
1:A:84:SER:OG	1:A:87:GLU:HG3	2.06	0.55
1:A:55:SER:CB	1:A:56:THR:CA	2.85	0.55
1:B:94:ARG:HH11	1:B:94:ARG:CG	2.18	0.55
1:A:18:GLU:OE2	1:A:49:THR:HG22	2.07	0.55
1:A:55:SER:HB3	1:A:56:THR:OG1	2.07	0.54
1:A:33:ARG:HG3	1:A:33:ARG:NH1	2.06	0.54
1:A:275:ASN:N	1:A:275:ASN:HD22	2.05	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:21:PRO:HA	1:A:48:ILE:CD1	2.38	0.54
1:A:218:ARG:HH11	1:A:218:ARG:HG3	1.73	0.53
1:B:275:ASN:N	1:B:276:LYS:HB2	2.23	0.53
1:A:7:LEU:HD13	1:A:203:PRO:HG2	1.91	0.53
1:A:56:THR:HB	1:A:59:ARG:HB2	1.89	0.53
1:B:212:THR:HG23	1:B:215:ARG:HH21	1.75	0.51
1:B:37:GLU:OE2	1:B:281:ARG:NH2	2.44	0.50
1:A:217:LEU:HG	1:A:228:ILE:HD13	1.93	0.50
1:A:53:MET:HE1	1:A:111:PRO:HD3	1.93	0.50
1:A:218:ARG:HG3	1:A:218:ARG:NH1	2.27	0.50
1:A:107:ARG:HD3	1:A:117:PHE:CE1	2.47	0.50
1:A:241:ASP:O	1:A:243:PRO:HD3	2.11	0.49
1:B:218:ARG:HG3	1:B:223:VAL:HG22	1.93	0.49
1:A:112:ARG:HG2	1:A:112:ARG:NH1	2.23	0.49
1:A:206:PRO:HD2	1:A:268:GLY:O	2.12	0.49
1:B:163:LEU:HD22	1:B:194:ARG:HB3	1.95	0.48
1:A:35:LEU:HD22	1:A:46:VAL:HG11	1.95	0.48
1:B:256:ARG:NE	4:B:421:HOH:O	2.47	0.48
1:B:188:TYR:CE2	1:B:192:LEU:HD11	2.49	0.48
1:A:1:MET:HG2	1:A:6:LEU:CD2	2.44	0.48
1:A:209:MET:HB2	1:A:272:TYR:HB2	1.96	0.48
1:B:211:VAL:HG12	1:B:250:GLY:HA2	1.95	0.48
1:A:120:HIS:ND1	1:A:121:PRO:HD2	2.29	0.47
1:B:77:HIS:CD2	1:B:109:ASP:OD2	2.52	0.47
1:B:84:SER:OG	1:B:87:GLU:HG3	2.15	0.47
1:B:212:THR:O	1:B:216:GLN:HG3	2.14	0.47
1:B:256:ARG:CD	4:B:421:HOH:O	2.63	0.47
1:A:19:PHE:O	1:A:49:THR:HG23	2.15	0.46
1:A:33:ARG:CG	1:A:33:ARG:NH1	2.69	0.46
1:A:153:HIS:HD2	1:A:162:ASP:OD1	1.99	0.46
1:A:228:ILE:HG23	1:A:232:LEU:HD23	1.97	0.46
1:B:8:LYS:HB3	1:B:8:LYS:HE2	1.81	0.46
1:B:125:ARG:NE	4:B:450:HOH:O	2.50	0.45
1:A:4:ARG:NH1	4:A:469:HOH:O	2.50	0.45
1:A:85:ARG:NH1	4:A:382:HOH:O	2.45	0.44
1:B:256:ARG:HD3	4:B:421:HOH:O	2.17	0.44
1:B:56:THR:OG1	4:B:571:HOH:O	2.21	0.44
1:B:215:ARG:HH11	1:B:219:ARG:CZ	2.31	0.44
1:B:10:ARG:NH2	1:B:267:GLU:HG2	2.33	0.43
1:A:1:MET:HG2	1:A:6:LEU:HD21	2.01	0.43
1:A:240:GLN:HG3	1:A:241:ASP:OD2	2.18	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:57:ARG:HH11	1:A:57:ARG:CB	2.22	0.43
1:B:79:THR:HG23	1:B:107:ARG:O	2.18	0.43
1:B:240:GLN:HE21	1:B:240:GLN:HB2	1.63	0.43
1:A:218:ARG:CG	1:A:218:ARG:NH1	2.74	0.43
1:A:8:LYS:CE	4:A:509:HOH:O	2.66	0.42
1:A:53:MET:CE	1:A:111:PRO:HD3	2.49	0.42
1:B:39:LYS:HD2	1:B:70:LEU:O	2.20	0.42
1:A:112:ARG:HH11	1:A:112:ARG:CG	2.22	0.42
1:A:57:ARG:HB3	1:A:57:ARG:NH1	2.20	0.42
1:B:212:THR:HB	4:B:399:HOH:O	2.19	0.42
1:A:52:ALA:H	1:A:55:SER:HA	1.85	0.41
1:A:51:GLY:HA2	1:A:54:GLY:O	2.20	0.41
1:A:20:PHE:HA	1:A:21:PRO:HD3	1.93	0.41
1:A:20:PHE:H	1:A:275:ASN:ND2	2.10	0.41
1:B:20:PHE:CG	1:B:21:PRO:HD2	2.56	0.41
1:A:8:LYS:HE2	1:A:8:LYS:HB2	1.89	0.41
1:A:125:ARG:HD3	1:A:126:TYR:CE2	2.56	0.41
1:B:20:PHE:CD1	1:B:21:PRO:HD2	2.56	0.41
1:B:180:GLN:HG2	1:B:224:CYS:SG	2.60	0.41
1:B:7:LEU:HD23	1:B:14:LEU:HD12	2.02	0.41
1:B:86:LYS:HD3	1:B:86:LYS:C	2.27	0.41
1:A:19:PHE:CE2	1:A:35:LEU:HD21	2.56	0.40
1:A:97:GLU:HG3	4:A:423:HOH:O	2.21	0.40
1:B:87:GLU:O	1:B:91:VAL:HG23	2.22	0.40
1:B:289:LEU:HA	1:B:289:LEU:HD23	1.78	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	290/310 (94%)	280 (97%)	8 (3%)	2 (1%)	22 9

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	B	269/310 (87%)	258 (96%)	7 (3%)	4 (2%)	10 2
All	All	559/620 (90%)	538 (96%)	15 (3%)	6 (1%)	14 4

All (6) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	158	SER
1	B	242	ASP
1	B	276	LYS
1	A	55	SER
1	B	240	GLN
1	A	51	GLY

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	236/249 (95%)	223 (94%)	13 (6%)	21 7
1	B	223/249 (90%)	196 (88%)	27 (12%)	5 0
All	All	459/498 (92%)	419 (91%)	40 (9%)	10 2

All (40) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	MET
1	A	11	ARG
1	A	33	ARG
1	A	34	THR
1	A	48	ILE
1	A	53	MET
1	A	57	ARG
1	A	107	ARG
1	A	112	ARG
1	A	157	GLU

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Mol	Chain	Res	Type
1	A	218	ARG
1	A	241	ASP
1	A	274	LEU
1	B	8	LYS
1	B	11	ARG
1	B	23	LYS
1	B	38	LEU
1	B	48	ILE
1	B	50	TYR
1	B	56	THR
1	B	58	GLU
1	B	77	HIS
1	B	78	LEU
1	B	79	THR
1	B	86	LYS
1	B	94	ARG
1	B	101	GLU
1	B	112	ARG
1	B	155	GLU
1	B	204	ILE
1	B	212	THR
1	B	217	LEU
1	B	219	ARG
1	B	221	THR
1	B	222	GLU
1	B	241	ASP
1	B	244	LYS
1	B	246	VAL
1	B	256	ARG
1	B	285	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	77	HIS
1	A	153	HIS
1	A	275	ASN
1	B	65	GLN
1	B	68	GLN
1	B	77	HIS
1	B	240	GLN

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 monosaccharides in this entry.

5.6 Ligand geometry (i)

2 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	$\#\|Z\| > 2$
3	ACT	B	311	-	3,3,3	1.74	1 (33%)	3,3,3	1.51	1 (33%)
2	FAD	A	311	-	53,58,58	1.51	4 (7%)	68,89,89	1.82	18 (26%)

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
2	FAD	A	311	-	-	0/30/50/50	0/6/6/6

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	311	FAD	C2A-N3A	5.71	1.41	1.32
2	A	311	FAD	C4X-N5	5.41	1.41	1.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	311	FAD	C2A-N1A	3.27	1.40	1.33
2	A	311	FAD	C10-N1	2.70	1.38	1.33
3	B	311	ACT	O-C	2.30	1.32	1.22

All (19) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	A	311	FAD	N3A-C2A-N1A	-5.96	119.36	128.68
2	A	311	FAD	C8M-C8-C9	-3.85	112.37	119.49
2	A	311	FAD	C7M-C7-C6	-3.53	112.97	119.49
2	A	311	FAD	C1B-N9A-C4A	-2.89	121.56	126.64
2	A	311	FAD	C4X-C10-N10	2.80	120.57	116.48
2	A	311	FAD	C6-C5X-C9A	2.69	122.74	118.94
2	A	311	FAD	C5X-C6-C7	-2.57	116.00	120.71
2	A	311	FAD	O4'-C4'-C5'	-2.46	104.38	109.92
2	A	311	FAD	O2-C2-N1	-2.44	117.79	121.83
2	A	311	FAD	C7M-C7-C8	2.41	125.68	120.74
2	A	311	FAD	C9-C8-C7	2.37	123.07	119.67
2	A	311	FAD	C9-C9A-N10	-2.27	118.77	121.84
2	A	311	FAD	C4A-C5A-N7A	-2.26	107.04	109.40
2	A	311	FAD	C10-C4X-N5	-2.22	120.15	124.86
2	A	311	FAD	O2'-C2'-C1'	-2.21	104.45	109.80
3	B	311	ACT	OXT-C-O	-2.15	114.14	122.05
2	A	311	FAD	C2A-N1A-C6A	2.11	122.36	118.75
2	A	311	FAD	C4X-C4-N3	2.04	118.37	113.19
2	A	311	FAD	C4-C4X-N5	2.01	121.09	118.23

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

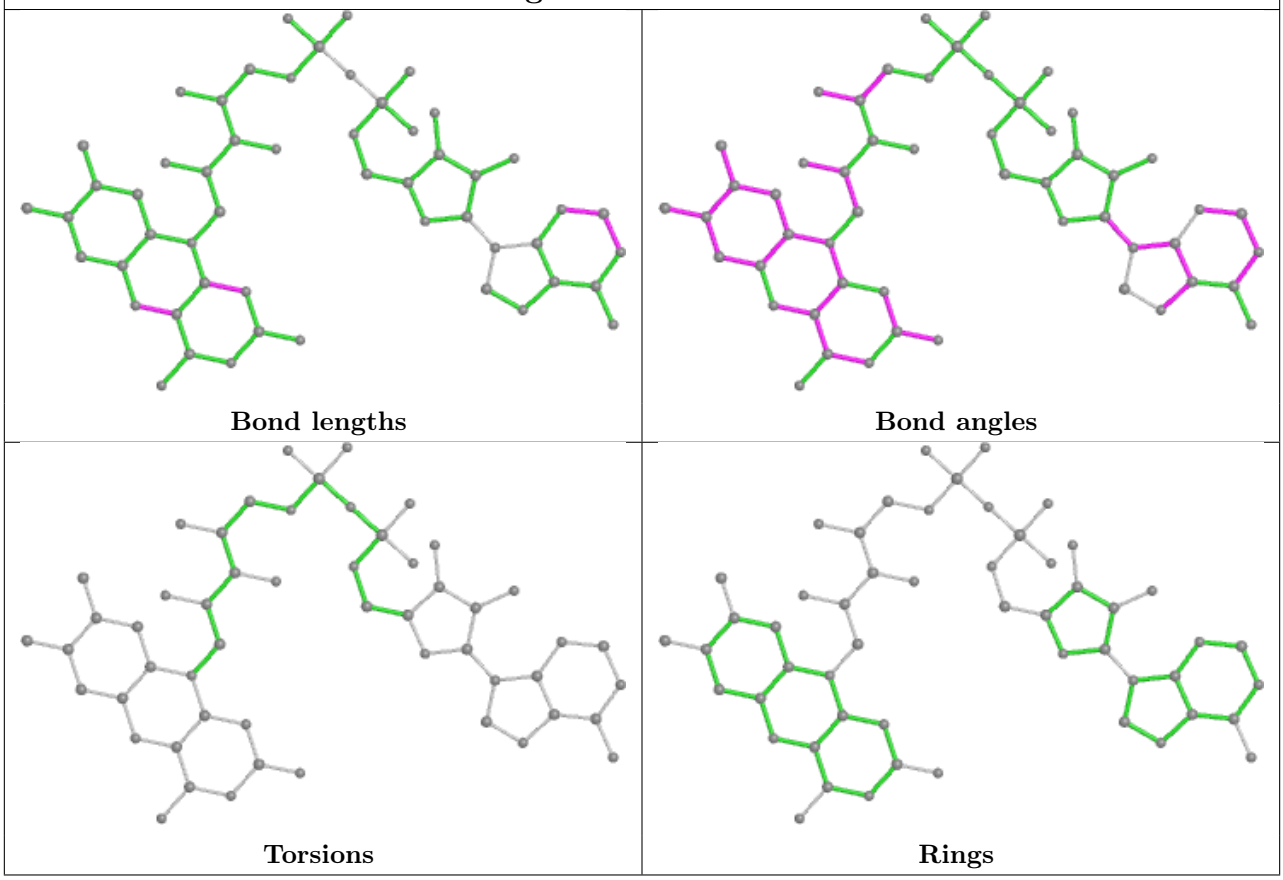
1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	311	FAD	1	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be

highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

Ligand FAD A 311



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	292/310 (94%)	0.38	18 (6%)	20	20	17, 30, 54, 76	1 (0%)
1	B	275/310 (88%)	0.53	21 (7%)	13	13	18, 35, 58, 73	0
All	All	567/620 (91%)	0.45	39 (6%)	16	16	17, 33, 57, 76	1 (0%)

All (39) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	220	PHE	9.0
1	A	52	ALA	8.4
1	A	55	SER	7.5
1	B	40	ALA	5.8
1	A	53	MET	5.5
1	A	112	ARG	5.5
1	B	11	ARG	4.4
1	B	57	ARG	4.4
1	A	113	GLY	4.4
1	B	56	THR	4.2
1	A	51	GLY	3.9
1	B	9	ALA	3.9
1	B	222	GLU	3.8
1	A	10	ARG	3.8
1	B	281	ARG	3.7
1	B	221	THR	3.6
1	B	241	ASP	3.5
1	A	292	ALA	3.4
1	B	219	ARG	3.2
1	B	285	GLU	3.2
1	A	111	PRO	3.2
1	B	82	GLY	3.1
1	A	54	GLY	3.1
1	A	56	THR	3.1

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Mol	Chain	Res	Type	RSRZ
1	A	218	ARG	3.0
1	B	97	GLU	2.9
1	A	241	ASP	2.7
1	A	276	LYS	2.6
1	A	215	ARG	2.4
1	A	121	PRO	2.4
1	B	275	ASN	2.4
1	A	157	GLU	2.3
1	B	23	LYS	2.3
1	B	244	LYS	2.2
1	B	217	LEU	2.2
1	B	236	LEU	2.2
1	A	23	LYS	2.1
1	B	238	ARG	2.1
1	B	154	PRO	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 monosaccharides in this entry.

6.4 Ligands (i)

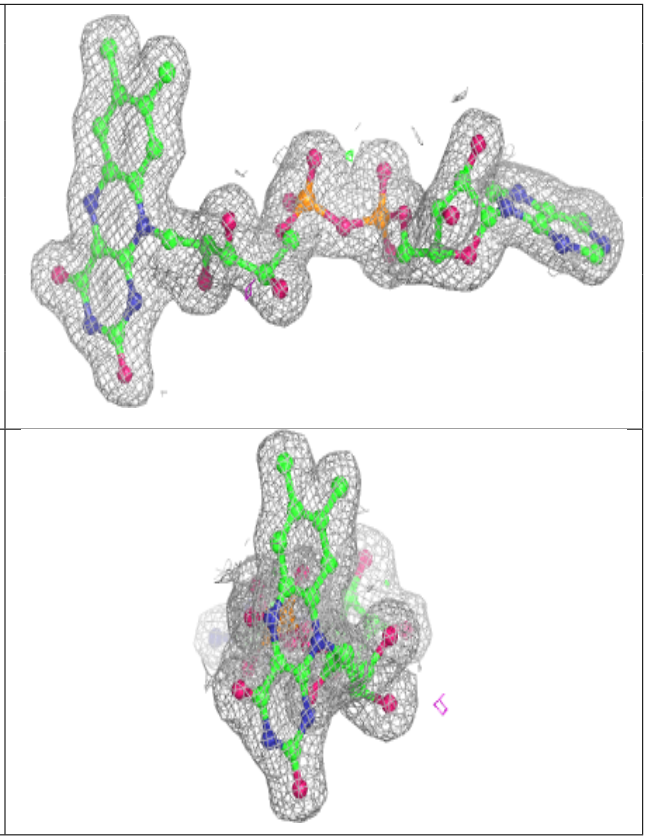
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	ACT	B	311	4/4	0.79	0.18	27,30,32,32	0
2	FAD	A	311	53/53	0.96	0.09	21,25,34,34	0

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around FAD A 311:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



6.5 Other polymers (i)

There are no such residues in this entry.