



wwPDB X-ray Structure Validation Summary Report ⓘ

Jan 30, 2024 – 10:02 AM EST

PDB ID : 1FO4
Title : CRYSTAL STRUCTURE OF XANTHINE DEHYDROGENASE ISOLATED FROM BOVINE MILK
Authors : Enroth, C.; Eger, B.T.; Okamoto, K.; Nishino, T.; Nishino, T.; Pai, E.F.
Deposited on : 2000-08-24
Resolution : 2.10 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 : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtrriage (Phenix) : **NOT EXECUTED**
EDS : **NOT EXECUTED**
buster-report : 1.1.7 (2018)
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.36

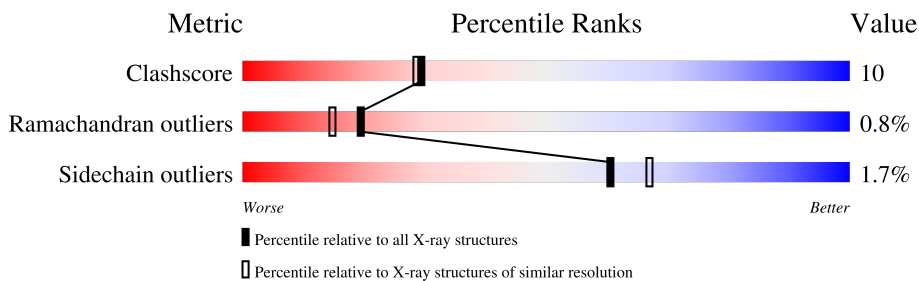
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.10 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))
Clashscore	141614	5710 (2.10-2.10)
Ramachandran outliers	138981	5647 (2.10-2.10)
Sidechain outliers	138945	5648 (2.10-2.10)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	1332	78% 18% ..
1	B	1332	79% 17% ..

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
5	MOS	A	3004	-	-	X	-
5	MOS	B	4004	-	-	X	-
7	FAD	A	3006	X	-	-	-
7	FAD	B	4006	X	-	-	-

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Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
8	GOL	A	3007	-	X	X	-
8	GOL	A	3008	-	X	-	-
8	GOL	B	4007	-	X	X	-
8	GOL	B	4008	-	X	X	-

2 Entry composition [i](#)

There are 9 unique types of molecules in this entry. The entry contains 22402 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.

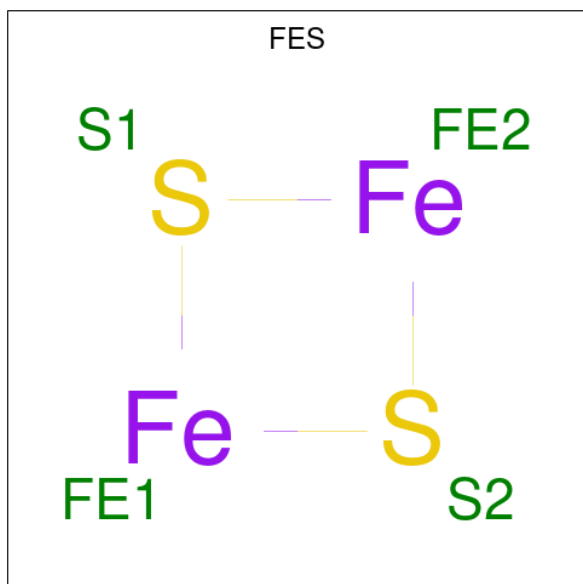
- Molecule 1 is a protein called XANTHINE DEHYDROGENASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	1299	10077	6404	1728	1884	61	0	0	0
1	B	1296	10054	6391	1724	1878	61	0	0	0

- Molecule 2 is CALCIUM ION (three-letter code: CA) (formula: Ca).

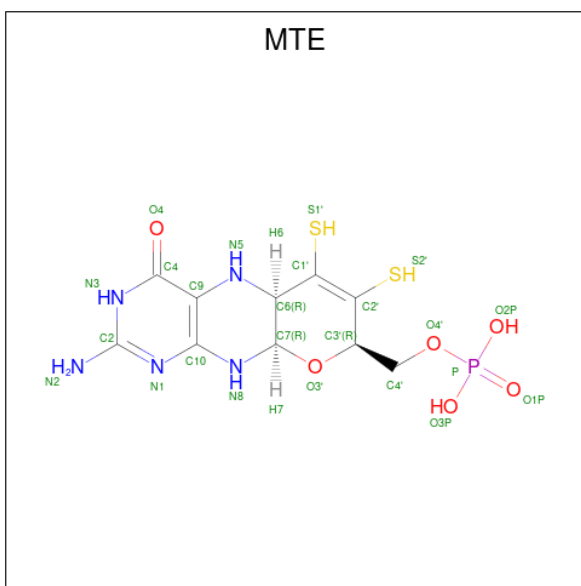
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Ca	0	0
			1	1		
2	B	1	Total	Ca	0	0
			1	1		

- Molecule 3 is FE2/S2 (INORGANIC) CLUSTER (three-letter code: FES) (formula: Fe₂S₂).



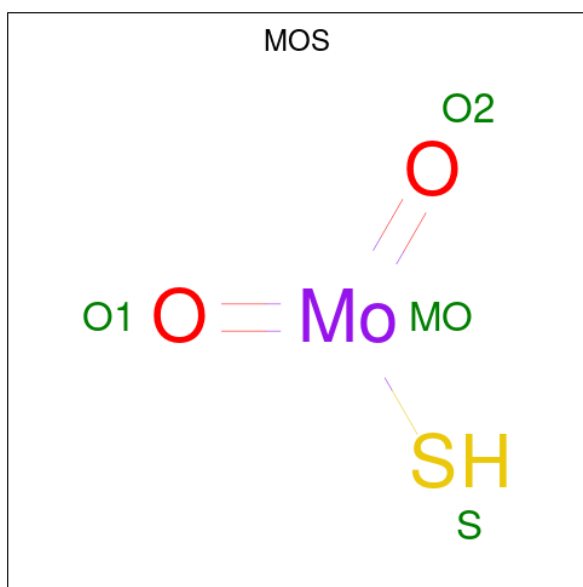
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	Fe	S	0	0
			4	2	2		
3	A	1	Total	Fe	S	0	0
			4	2	2		
3	B	1	Total	Fe	S	0	0
			4	2	2		
3	B	1	Total	Fe	S	0	0
			4	2	2		

- Molecule 4 is PHOSPHONIC ACIDMONO-(2-AMINO-5,6-DIMERCAPTO-4-OXO-3,7,8A,9,10,10A-HEXAHYDRO-4H-8-OXA-1,3,9,10-TETRAAZA-ANTHRACEN-7-YLMETHYL) ESTER (three-letter code: MTE) (formula: C₁₀H₁₄N₅O₆PS₂).



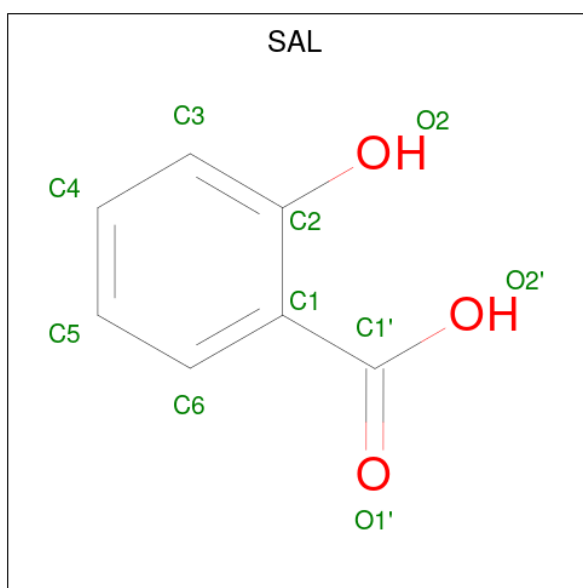
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	
4	A	1	Total	C	N	O	P	S	0	0
			24	10	5	6	1	2		
4	B	1	Total	C	N	O	P	S	0	0
			24	10	5	6	1	2		

- Molecule 5 is DIOXOTHIOMOLYBDENUM(VI) ION (three-letter code: MOS) (formula: HMoO₂S).



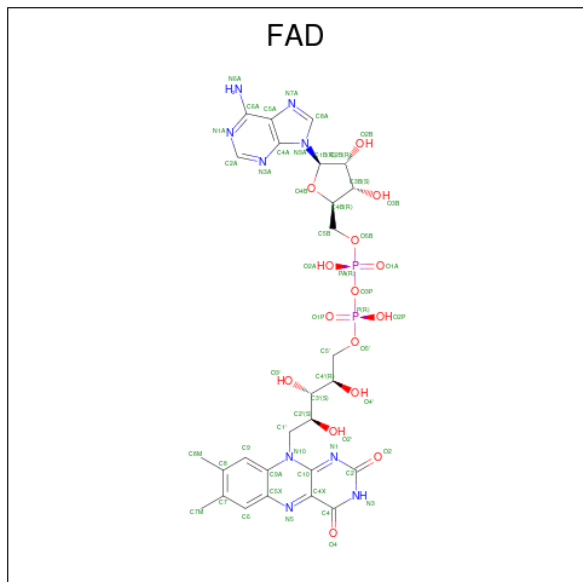
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	Mo	O	S		
5	A	1	4	1	2	1	0	0
5	B	1	4	1	2	1	0	0

- Molecule 6 is 2-HYDROXYBENZOIC ACID (three-letter code: SAL) (formula: C₇H₆O₃).



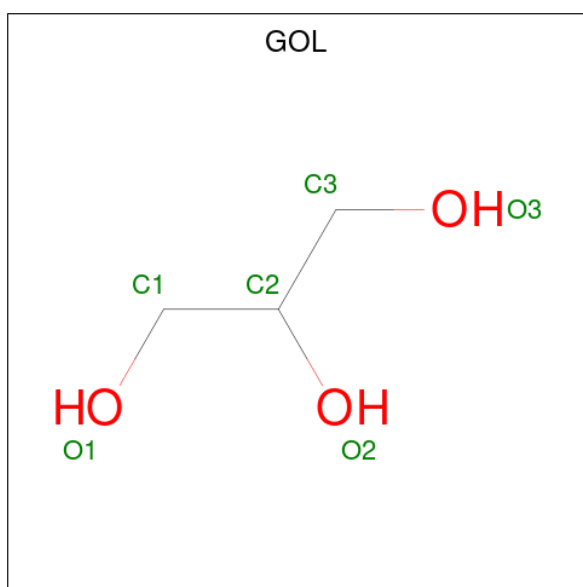
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
6	A	1	10	7	3	0	0
6	B	1	10	7	3	0	0

- Molecule 7 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
7	A	1	53	27	9	15	2	0	0
7	B	1	53	27	9	15	2	0	0

- Molecule 8 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	A	1	Total C O 6 3 3	0	0
8	A	1	Total C O 6 3 3	0	0
8	B	1	Total C O 6 3 3	0	0
8	B	1	Total C O 6 3 3	0	0

- Molecule 9 is water.


Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
9	A	1047	Total O 1047 1047	0	0
9	B	1000	Total O 1000 1000	0	0

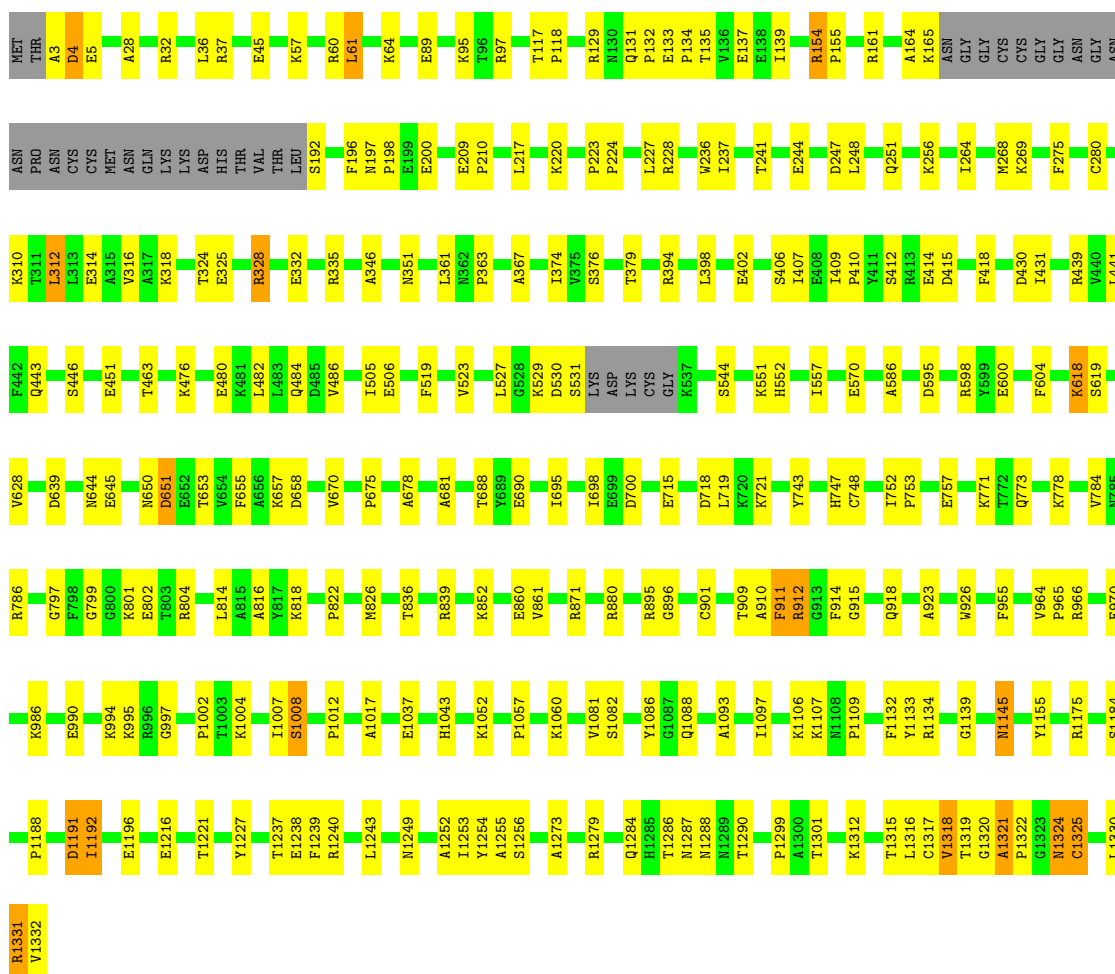
3 Residue-property plots [i](#)

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. Residues are color-coded 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.


Note EDS was not executed.

- Molecule 1: XANTHINE DEHYDROGENASE

Chain A:  78% 18% ..



- Molecule 1: XANTHINE DEHYDROGENASE

Chain B:  79% 17% ..

	F1289	L1054	G837	R508	I313	GLY	MET
	N1249	K1055	G838	R509	E314	ASN	THR
	A1252	P1072	H840	T512	R328	ASN	A3
	A1255	V1081	A844	L527	L331	ASN	P22
	S1256	S1082	K847	G528	E332	ASN	L36
	E1261	I1085	K852	LYS	R335	CYS	R37
	P1262	Q1088	E860	ASP	W336	MET	K57
	A1281	A1093	E879	LYS	F337	ASN	Q62
	Q1284	I1097	R880	CYS	A338	GLN	D63
	H1285	M1108	M885	GLY	K340	LYS	I66
	T1286	P1109	L719	K537	A346	ASP	I66
	N1287	R1124	K721	L538	A346	HIS	H82
	M1288	R895	G722	L548	N351	THR	H82
	N1289	V1125	F723	H552	L361	THR	E89
	T1290	S1126	S724	N565	I374	LEU	G90
	K1291	T1129	A726	K569	S376	S192	I91
	E1292	Y1133	D727	A586	G378	E200	K95
	L1293	R1134	Q739	D596	T379	E209	H99
	F1294	G1139	H741	R394	R394	P210	P100
	P1299	F1142	L743	R598	L398	L217	H109
	A1300	M1145	L744	E500	E402	K220	T117
	T1301	K1172	H747	R606	I407	G231	P118
	P1302	M1173	I752	L607	R427	T241	R129
	V1310	L1174	E757	V608	E498	K243	M300
	D1311	R1175	E761	T609	D429	E244	Q131
	F1313	S1184	K778	A615	L441	K256	P132
	L1316	L1185	M779	K616	M447	L257	E133
	C1317	M1187	R786	S619	V628	V258	P134
	V1318	P1188	I787	F634	E451	I264	T135
	A1321	A1189	L788	E645	Q471	F275	E138
	P1322	I1190	K986	N650	Q473	C280	D141
	G1323	D1191	F987	D651	K476	P281	Q144
	M1324	I1192	E990	V810	E480	C280	C150
	K1326	V1195	K995	T659	K481	I284	R154
	L1330	E1196	R996	P822	L482	L287	R161
	R1331	T1207	R996	M833	Q484	K310	A164
	V1332	L1208	I1007	L835	V485	T311	A164
		T1221	S1008	T836	R680	CYS	ASN
		Y1227	A1017		D486	GLY	ASN
		P1236			V486	CYS	GLY
						GLY	GLY

4 Data and refinement statistics

Xtrriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	169.45Å 124.49Å 148.33Å 90.00° 90.94° 90.00°	Depositor
Resolution (Å)	25.00 – 2.10	Depositor
% Data completeness (in resolution range)	86.9 (25.00-2.10)	Depositor
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS	Depositor
R, R_{free}	0.198 , 0.238	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	22402	wwPDB-VP
Average B, all atoms (Å ²)	30.0	wwPDB-VP

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: MTE, CA, FES, FAD, SAL, MOS, GOL

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	0.37	0/10298	0.64	1/13939 (0.0%)
1	B	0.37	0/10275	0.64	1/13909 (0.0%)
All	All	0.37	0/20573	0.64	2/27848 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	1191	ASP	N-CA-C	-5.23	96.89	111.00
1	B	243	LYS	N-CA-C	-5.00	97.49	111.00

There are no chirality outliers.

There are no planarity outliers.

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	10077	0	10075	203	0
1	B	10054	0	10054	181	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	8	0	0	0	0
3	B	8	0	0	0	0
4	A	24	0	10	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	B	24	0	10	2	0
5	A	4	0	0	2	0
5	B	4	0	0	2	0
6	A	10	0	4	0	0
6	B	10	0	4	1	0
7	A	53	0	29	3	0
7	B	53	0	30	2	0
8	A	12	0	5	7	0
8	B	12	0	7	11	0
9	A	1047	0	0	21	0
9	B	1000	0	0	11	0
All	All	22402	0	20228	386	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 10.

The worst 5 of 386 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)
8:A:3008:GOL:O1	8:A:3008:GOL:C1	1.68	1.39
8:B:4008:GOL:O1	8:B:4008:GOL:C1	1.71	1.36
1:A:3:ALA:HB1	1:A:228:ARG:H	1.19	1.07
1:B:645:GLU:HG2	1:B:650:ASN:HD22	1.19	1.07
5:B:4004:MOS:S	5:B:4004:MOS:MO	1.66	1.06

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	1293/1332 (97%)	1228 (95%)	54 (4%)	11 (1%)	17 12

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	1290/1332 (97%)	1236 (96%)	45 (4%)	9 (1%)	22	18
All	All	2583/2664 (97%)	2464 (95%)	99 (4%)	20 (1%)	19	15

5 of 20 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	1008	SER
1	A	1331	ARG
1	B	244	GLU
1	B	1008	SER
1	B	1287	ASN

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	1101/1128 (98%)	1084 (98%)	17 (2%)	65	71
1	B	1098/1128 (97%)	1078 (98%)	20 (2%)	59	65
All	All	2199/2256 (98%)	2162 (98%)	37 (2%)	60	67

5 of 37 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	744	LEU
1	B	1326	LYS
1	B	899	ARG
1	B	1239	PHE
1	A	1145	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 21 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	473	GLN
1	B	650	ASN

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Mol	Chain	Res	Type
1	B	1287	ASN
1	B	1145	ASN
1	B	626	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](#)

Of 18 ligands modelled in this entry, 2 are monoatomic - leaving 16 for Mogul analysis.

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
5	MOS	A	3004	4	0,3,3	-	-	-		
8	GOL	B	4007	-	5,5,5	6.43	5 (100%)	5,5,5	6.00	3 (60%)
7	FAD	B	4006	-	53,58,58	4.20	33 (62%)	68,89,89	2.14	20 (29%)
8	GOL	B	4008	-	5,5,5	4.29	3 (60%)	5,5,5	6.16	3 (60%)
3	FES	B	4001	1	0,4,4	-	-	-		
3	FES	A	3002	1	0,4,4	-	-	-		
4	MTE	B	4003	5	21,26,26	7.10	13 (61%)	21,40,40	3.66	9 (42%)
3	FES	B	4002	1	0,4,4	-	-	-		
5	MOS	B	4004	4	0,3,3	-	-	-		
3	FES	A	3001	1	0,4,4	-	-	-		

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
4	MTE	A	3003	5	21,26,26	7.16	17 (80%)	21,40,40	3.76	9 (42%)
6	SAL	A	3005	-	10,10,10	1.93	5 (50%)	13,13,13	2.06	4 (30%)
6	SAL	B	4005	-	10,10,10	1.91	5 (50%)	13,13,13	2.11	4 (30%)
8	GOL	A	3007	-	5,5,5	6.80	5 (100%)	5,5,5	6.09	4 (80%)
7	FAD	A	3006	-	53,58,58	4.39	33 (62%)	68,89,89	2.17	20 (29%)
8	GOL	A	3008	-	5,5,5	4.37	3 (60%)	5,5,5	6.03	3 (60%)

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
8	GOL	B	4007	-	-	2/4/4/4	-
7	FAD	B	4006	-	2/2/9/9	3/30/50/50	0/6/6/6
8	GOL	B	4008	-	-	2/4/4/4	-
3	FES	B	4001	1	-	-	0/1/1/1
4	MTE	B	4003	5	-	1/6/34/34	0/3/3/3
3	FES	A	3002	1	-	-	0/1/1/1
3	FES	B	4002	1	-	-	0/1/1/1
3	FES	A	3001	1	-	-	0/1/1/1
4	MTE	A	3003	5	-	1/6/34/34	0/3/3/3
6	SAL	A	3005	-	-	0/4/4/4	0/1/1/1
6	SAL	B	4005	-	-	0/4/4/4	0/1/1/1
8	GOL	A	3007	-	-	2/4/4/4	-
7	FAD	A	3006	-	2/2/9/9	3/30/50/50	0/6/6/6
8	GOL	A	3008	-	-	2/4/4/4	-

The worst 5 of 122 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	4003	MTE	C7-C6	23.94	1.72	1.53
4	A	3003	MTE	C7-C6	22.52	1.71	1.53
4	B	4003	MTE	C9-C10	14.64	1.69	1.41
4	A	3003	MTE	C9-C10	13.36	1.66	1.41
8	A	3007	GOL	C3-C2	-12.47	1.00	1.51

The worst 5 of 79 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
8	A	3007	GOL	O3-C3-C2	11.67	166.16	110.20
8	B	4008	GOL	O3-C3-C2	11.50	165.33	110.20
8	B	4007	GOL	O3-C3-C2	11.44	165.04	110.20
4	A	3003	MTE	C4-C9-N5	10.93	128.29	119.12
8	A	3008	GOL	O3-C3-C2	10.91	162.50	110.20

All (4) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
7	A	3006	FAD	C2'
7	A	3006	FAD	C3'
7	B	4006	FAD	C2'
7	B	4006	FAD	C3'

5 of 16 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	3003	MTE	C3'-C4'-O4'-P
4	B	4003	MTE	C3'-C4'-O4'-P
8	A	3007	GOL	C1-C2-C3-O3
8	A	3008	GOL	O1-C1-C2-C3
8	A	3008	GOL	C1-C2-C3-O3

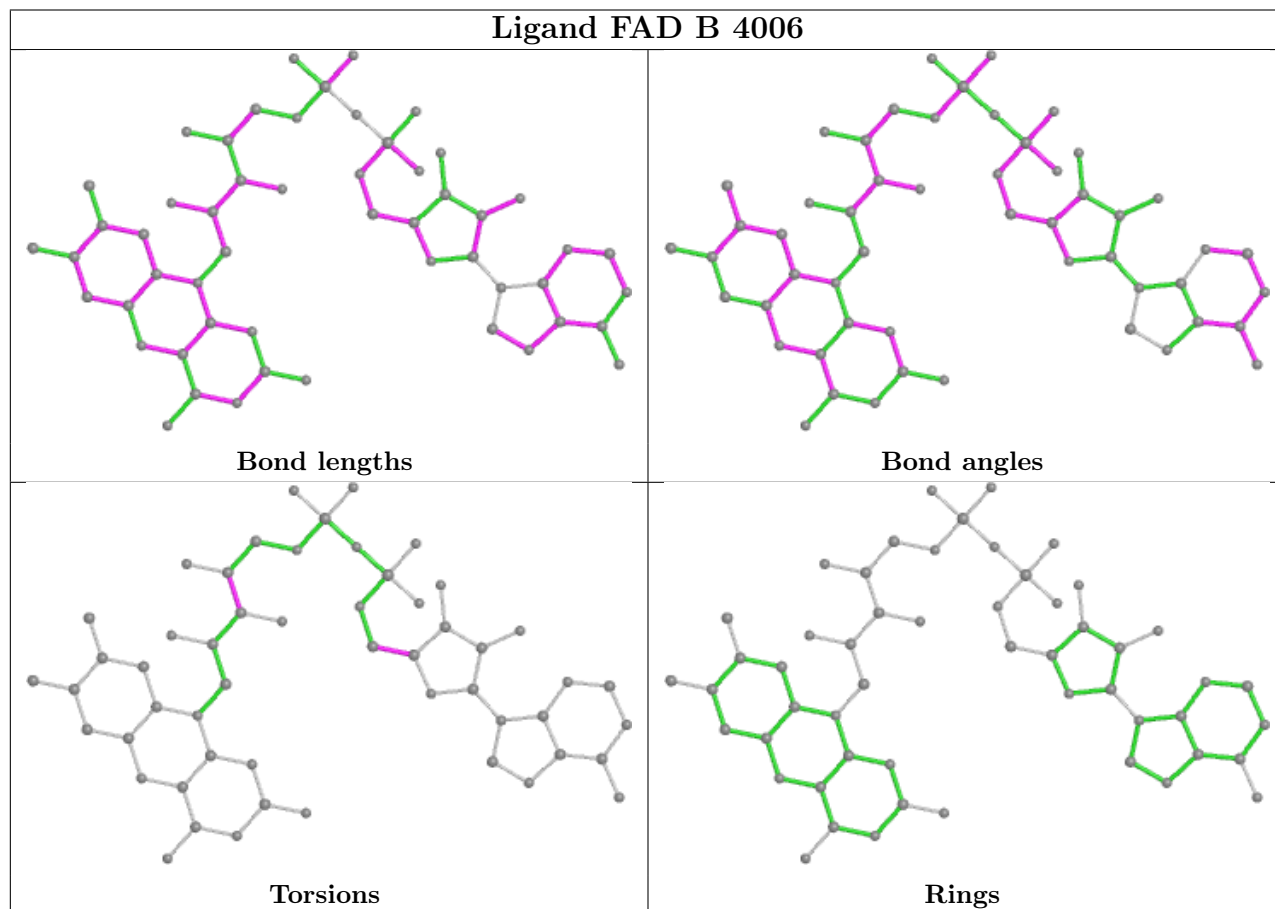
There are no ring outliers.

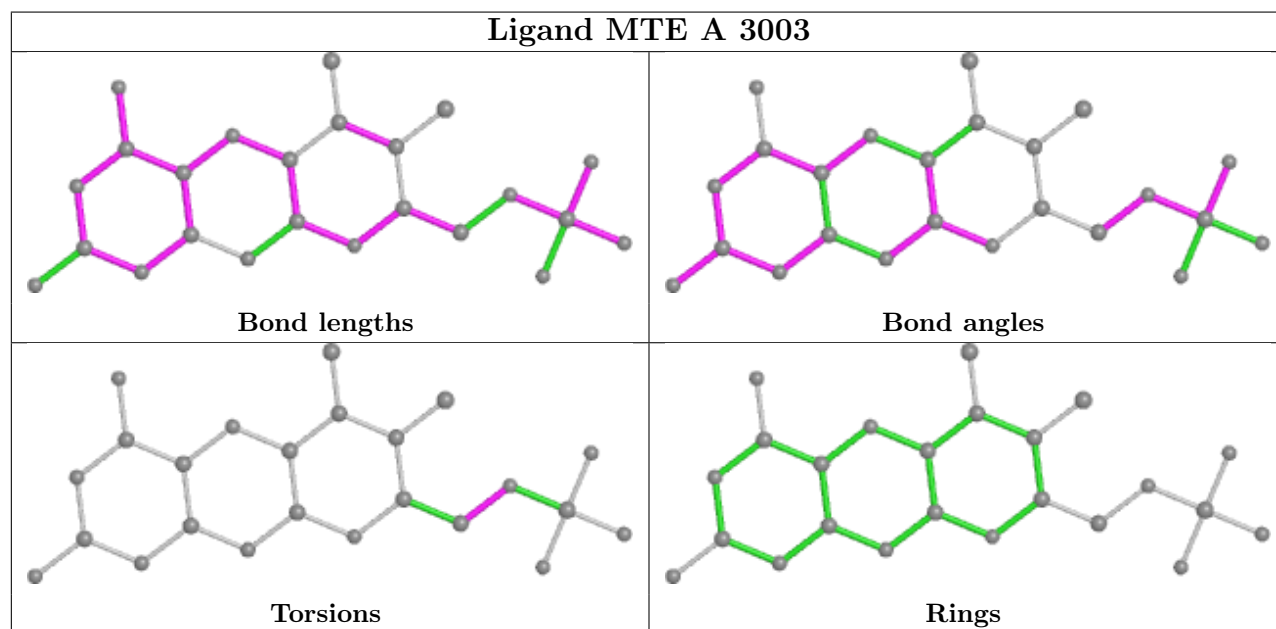
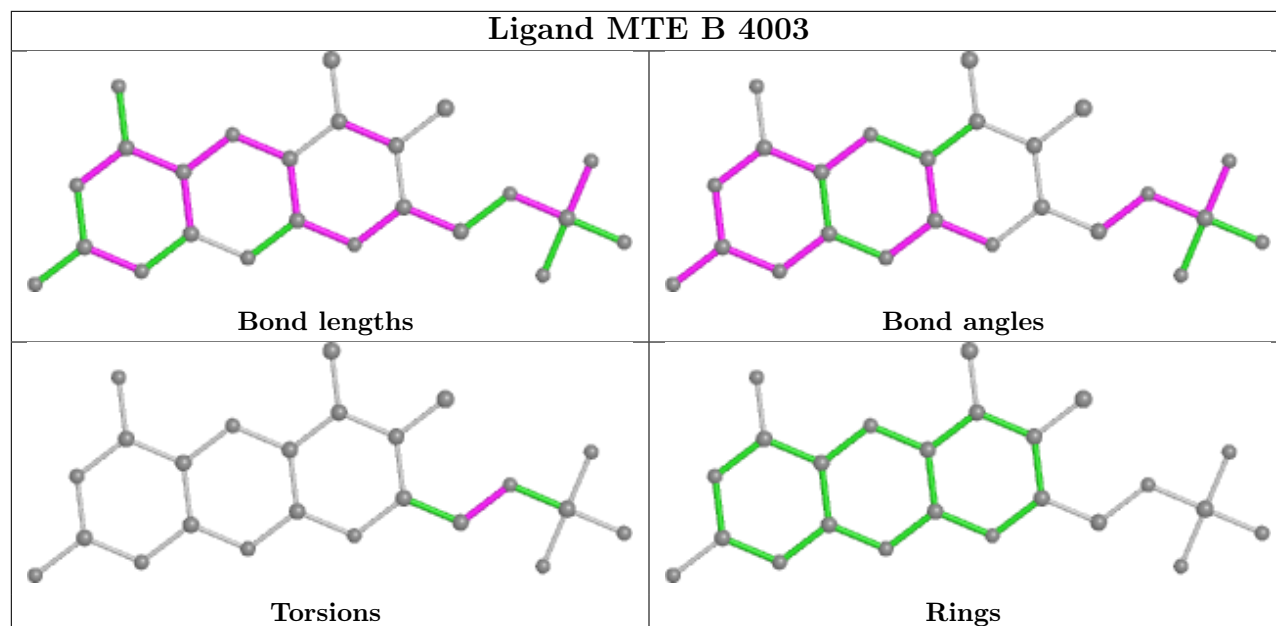
11 monomers are involved in 31 short contacts:

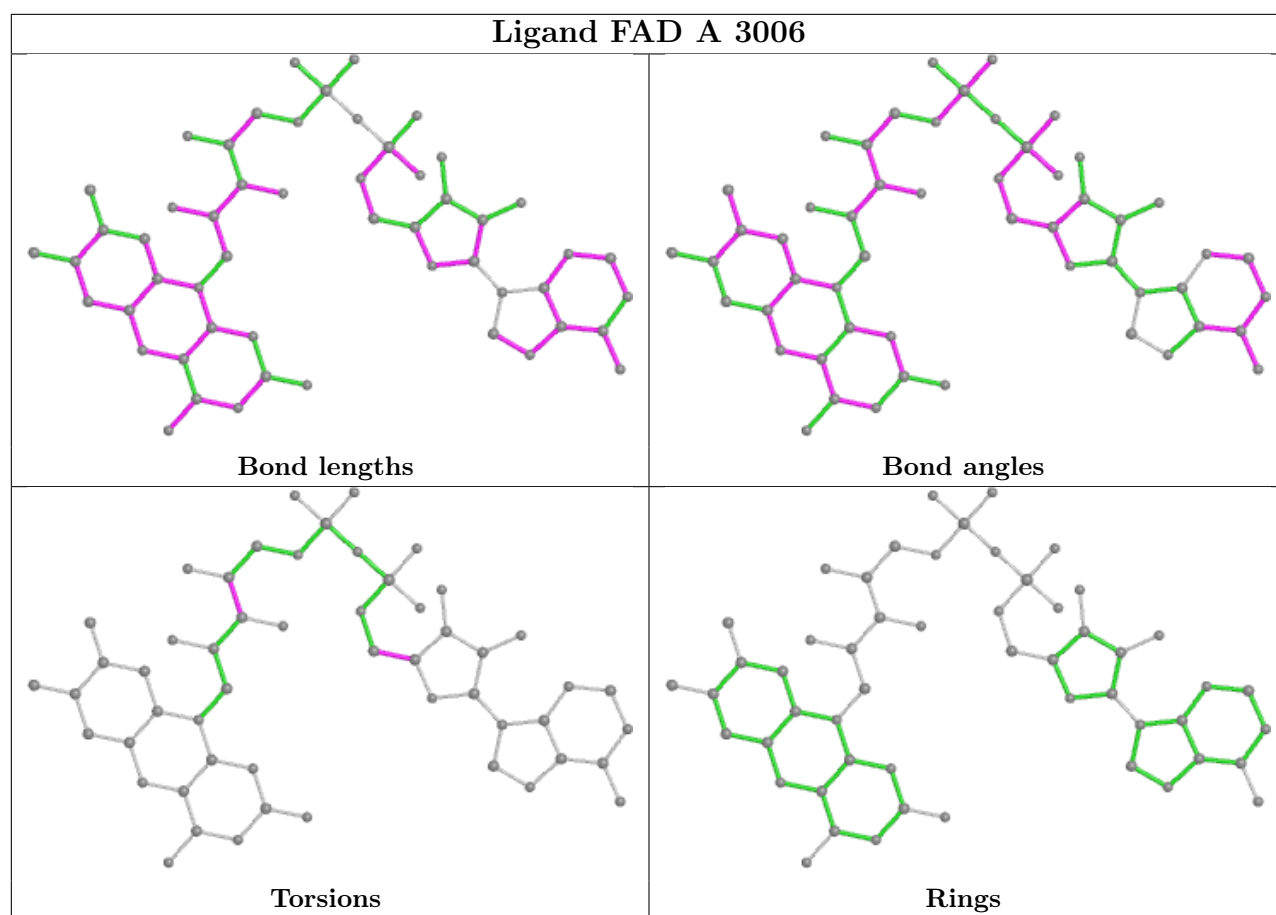
Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	3004	MOS	2	0
8	B	4007	GOL	7	0
7	B	4006	FAD	2	0
8	B	4008	GOL	4	0
4	B	4003	MTE	2	0
5	B	4004	MOS	2	0
4	A	3003	MTE	1	0
6	B	4005	SAL	1	0
8	A	3007	GOL	4	0
7	A	3006	FAD	3	0
8	A	3008	GOL	3	0

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 than 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.







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](#)

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates [i](#)

EDS was not executed - this section is therefore empty.

6.4 Ligands [i](#)

EDS was not executed - this section is therefore empty.

6.5 Other polymers [i](#)

EDS was not executed - this section is therefore empty.