



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 12:55 AM UTC

PDB ID : 7DFR / pdb_00007dfr
Title : CRYSTAL STRUCTURES OF ESCHERICHIA COLI DIHYDROFOLATE REDUCTASE. THE NADP⁺ HOLOENZYME AND THE FOLATE(DOT)NADP⁺ TERNARY COMPLEX. SUBSTRATE BINDING AND A MODEL FOR THE TRANSITION STATE
Authors : Bystroff, C.; Oatley, S.J.; Kraut, J.
Deposited on : 1988-10-21
Resolution : 2.50 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 ⓘ 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)
Xtrriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

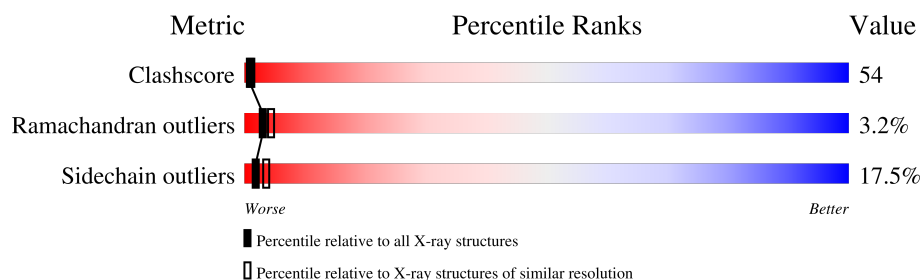
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.50 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	190562	6492 (2.50-2.50)
Ramachandran outliers	187476	6378 (2.50-2.50)
Sidechain outliers	187428	6380 (2.50-2.50)

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	159	26% 43% 24% 7%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 1364 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.

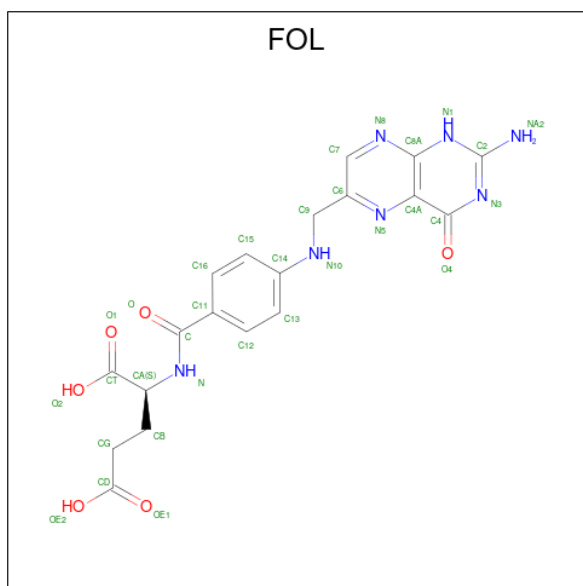
- Molecule 1 is a protein called DIHYDROFOLATE REDUCTASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	159	Total	C	N	O	S	0	0	0
			1229	788	206	228	7			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	37	ASP	ASN	conflict	UNP P0ABQ4

- Molecule 2 is FOLIC ACID (CCD ID: FOL) (formula: C₁₉H₁₉N₇O₆).





Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total 48	C 21	N 7	O 17	P 3	0	0

- Molecule 4 is water.

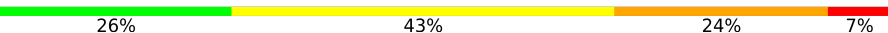
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	55	Total O 55 55	0	0

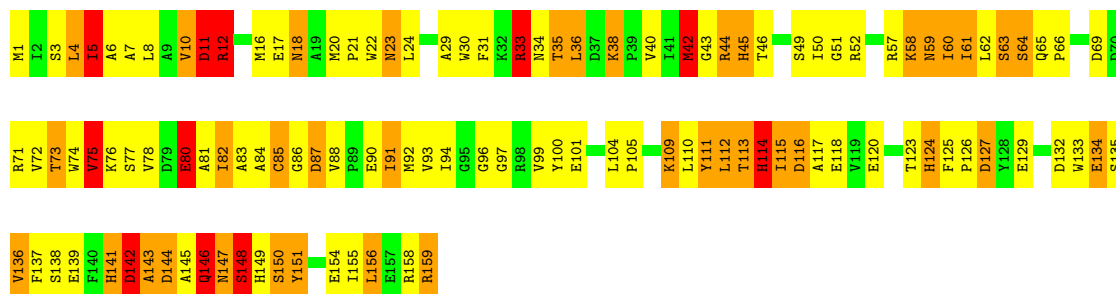
3 Residue-property plots [i](#)

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 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.

Note EDS was not executed.

• Molecule 1: DIHYDROFOLATE REDUCTASE

Chain A: 



4 Data and refinement statistics

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

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, α , β , γ	62.21Å 62.21Å 105.53Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	(Not available) – 2.50	Depositor
% Data completeness (in resolution range)	(Not available) ((Not available)-2.50)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	PROLSQ	Depositor
R, R_{free}	0.245 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	1364	wwPDB-VP
Average B, all atoms (Å ²)	43.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

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

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	1.66	8/1263 (0.6%)	2.34	65/1720 (3.8%)

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	4

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	113	THR	N-CA	-9.99	1.33	1.46
1	A	141	HIS	CE1-NE2	-6.43	1.26	1.32
1	A	114	HIS	N-CA	6.08	1.54	1.46
1	A	144	ASP	CA-CB	-5.91	1.45	1.53
1	A	35	THR	CA-CB	5.58	1.62	1.53
1	A	59	ASN	N-CA	-5.48	1.39	1.46
1	A	145	ALA	N-CA	5.39	1.52	1.46
1	A	91	ILE	CA-CB	5.34	1.60	1.54

All (65) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	59	ASN	CA-CB-CG	17.93	130.53	112.60
1	A	112	LEU	CA-C-N	12.98	139.71	122.84
1	A	112	LEU	C-N-CA	12.98	139.71	122.84
1	A	11	ASP	CA-CB-CG	12.14	124.74	112.60
1	A	18	ASN	CA-CB-CG	9.64	122.24	112.60

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	151	TYR	O-C-N	9.52	132.88	123.46
1	A	64	SER	N-CA-C	-9.03	100.85	112.23
1	A	145	ALA	CA-C-N	9.02	132.70	120.44
1	A	145	ALA	C-N-CA	9.02	132.70	120.44
1	A	34	ASN	CA-CB-CG	-8.95	103.65	112.60
1	A	87	ASP	CA-CB-CG	-8.91	103.69	112.60
1	A	5	ILE	CB-CA-C	8.32	121.44	110.12
1	A	113	THR	CA-C-N	-8.11	111.57	122.85
1	A	113	THR	C-N-CA	-8.11	111.57	122.85
1	A	127	ASP	CA-CB-CG	-7.96	104.64	112.60
1	A	129	GLU	CA-C-N	7.50	129.22	119.84
1	A	129	GLU	C-N-CA	7.50	129.22	119.84
1	A	72	VAL	CA-C-N	7.21	132.18	121.72
1	A	72	VAL	C-N-CA	7.21	132.18	121.72
1	A	124	HIS	CA-CB-CG	-7.20	106.60	113.80
1	A	80	GLU	N-CA-C	-7.19	103.13	110.97
1	A	6	ALA	CA-C-N	7.13	133.48	123.07
1	A	6	ALA	C-N-CA	7.13	133.48	123.07
1	A	12	ARG	CD-NE-CZ	-6.93	114.70	124.40
1	A	38	LYS	O-C-N	6.79	126.70	121.88
1	A	33	ARG	CA-CB-CG	6.70	127.50	114.10
1	A	88	VAL	O-C-N	6.65	127.49	121.57
1	A	146	GLN	N-CA-C	6.62	118.29	111.14
1	A	23	ASN	CA-C-N	6.44	129.93	122.85
1	A	23	ASN	C-N-CA	6.44	129.93	122.85
1	A	75	VAL	CB-CA-C	6.38	122.66	111.18
1	A	118	GLU	CA-CB-CG	6.30	126.71	114.10
1	A	58	LYS	CA-C-N	6.26	130.75	122.42
1	A	58	LYS	C-N-CA	6.26	130.75	122.42
1	A	127	ASP	CA-C-O	-6.19	114.87	122.36
1	A	63	SER	O-C-N	6.18	130.64	123.41
1	A	64	SER	CA-C-N	6.13	131.73	121.92
1	A	64	SER	C-N-CA	6.13	131.73	121.92
1	A	134	GLU	CB-CG-CD	6.13	123.02	112.60
1	A	42	MET	CG-SD-CE	-6.03	87.64	100.90
1	A	116	ASP	CA-CB-CG	-6.02	106.58	112.60
1	A	109	LYS	CA-CB-CG	6.01	126.13	114.10
1	A	146	GLN	CB-CG-CD	-5.78	102.77	112.60
1	A	135	SER	CA-C-O	-5.77	114.06	120.70
1	A	42	MET	CA-C-N	5.73	126.50	121.58
1	A	42	MET	C-N-CA	5.73	126.50	121.58
1	A	101	GLU	CA-CB-CG	5.63	125.37	114.10

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	148	SER	CA-CB-OG	5.55	122.19	111.10
1	A	147	ASN	CA-CB-CG	-5.52	107.08	112.60
1	A	144	ASP	CA-C-O	-5.49	115.23	120.94
1	A	44	ARG	CA-C-O	-5.49	114.78	120.92
1	A	146	GLN	CB-CA-C	-5.45	102.29	110.90
1	A	150	SER	N-CA-C	-5.44	102.70	110.59
1	A	45	HIS	N-CA-CB	5.43	118.20	110.16
1	A	73	THR	CA-CB-OG1	-5.40	101.49	109.60
1	A	12	ARG	CA-C-N	5.37	129.24	121.18
1	A	12	ARG	C-N-CA	5.37	129.24	121.18
1	A	113	THR	N-CA-CB	5.36	119.21	110.37
1	A	85	CYS	N-CA-CB	5.29	118.40	110.19
1	A	44	ARG	N-CA-CB	5.26	118.36	109.78
1	A	142	ASP	O-C-N	5.24	128.93	123.06
1	A	114	HIS	CA-CB-CG	5.22	119.02	113.80
1	A	146	GLN	OE1-CD-NE2	5.16	127.76	122.60
1	A	111	TYR	CA-C-O	-5.11	113.41	120.52
1	A	147	ASN	OD1-CG-ND2	5.01	127.61	122.60

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	114	HIS	Mainchain
1	A	12	ARG	Sidechain
1	A	159	ARG	Sidechain
1	A	33	ARG	Sidechain

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	1229	0	1169	136	0
2	A	32	0	17	2	0
3	A	48	0	25	16	0
4	A	55	0	0	7	2
All	All	1364	0	1211	137	2

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 54.

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:155:ILE:C	1:A:156:LEU:HD12	1.74	1.12
1:A:146:GLN:HB2	1:A:147:ASN:ND2	1.66	1.11
1:A:116:ASP:HB2	4:A:311:HOH:O	1.53	1.06
1:A:120:GLU:HB2	4:A:240:HOH:O	1.54	1.04
1:A:156:LEU:HD12	1:A:156:LEU:N	1.75	1.00
1:A:113:THR:HG22	1:A:115:ILE:CD1	1.97	0.94
1:A:104:LEU:CD2	1:A:126:PRO:HB2	1.98	0.94
1:A:5:ILE:HG13	1:A:111:TYR:HB2	1.52	0.89
1:A:104:LEU:HB3	1:A:105:PRO:HD3	1.59	0.84
1:A:45:HIS:ND1	3:A:164:NAP:O5B	2.11	0.84
1:A:78:VAL:O	1:A:81:ALA:HB3	1.77	0.83
1:A:156:LEU:N	1:A:156:LEU:CD1	2.41	0.82
1:A:65:GLN:HB3	1:A:66:PRO:HD2	1.62	0.81
1:A:80:GLU:O	1:A:83:ALA:HB3	1.82	0.78
1:A:154:GLU:HG2	1:A:156:LEU:HD11	1.65	0.78
1:A:146:GLN:HB2	1:A:147:ASN:HD22	1.46	0.77
1:A:60:ILE:C	1:A:61:ILE:HD13	2.10	0.75
1:A:62:LEU:HD12	3:A:164:NAP:C6A	2.16	0.75
1:A:74:TRP:O	1:A:75:VAL:CG1	2.34	0.74
1:A:10:VAL:O	1:A:11:ASP:HB3	1.88	0.74
1:A:62:LEU:HD12	3:A:164:NAP:C5A	2.19	0.72
1:A:113:THR:CG2	1:A:115:ILE:CD1	2.67	0.72
1:A:74:TRP:O	1:A:75:VAL:HG12	1.89	0.71
1:A:104:LEU:HD22	1:A:126:PRO:HB2	1.72	0.70
1:A:65:GLN:O	4:A:310:HOH:O	2.09	0.69
1:A:154:GLU:HG2	1:A:156:LEU:CD1	2.24	0.68
1:A:5:ILE:CG1	1:A:111:TYR:HB2	2.24	0.67
1:A:16:MET:O	1:A:17:GLU:C	2.38	0.67
1:A:155:ILE:CA	1:A:156:LEU:HD12	2.25	0.66
1:A:1:MET:HE3	1:A:3:SER:OG	1.96	0.66
1:A:45:HIS:HD1	3:A:164:NAP:C5B	2.09	0.65
1:A:136:VAL:O	1:A:136:VAL:HG23	1.96	0.65
1:A:104:LEU:HD23	1:A:126:PRO:HB2	1.79	0.65
1:A:61:ILE:HD13	1:A:61:ILE:N	2.12	0.64
1:A:8:LEU:HD12	1:A:8:LEU:N	2.13	0.64
1:A:5:ILE:HG13	1:A:111:TYR:CB	2.26	0.64
1:A:45:HIS:CE1	3:A:164:NAP:H51A	2.34	0.63

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:42:MET:HG2	1:A:94:ILE:HD11	1.81	0.62
1:A:114:HIS:O	1:A:151:TYR:HA	2.00	0.62
1:A:58:LYS:HE3	1:A:84:ALA:O	1.99	0.62
1:A:4:LEU:HD12	1:A:93:VAL:HB	1.82	0.61
1:A:133:TRP:CZ3	1:A:158:ARG:N	2.68	0.61
1:A:65:GLN:CB	1:A:66:PRO:HD2	2.30	0.61
1:A:45:HIS:ND1	3:A:164:NAP:C5B	2.63	0.61
1:A:113:THR:HG22	1:A:115:ILE:HD12	1.82	0.61
1:A:154:GLU:CG	1:A:156:LEU:HD11	2.29	0.61
1:A:78:VAL:O	1:A:82:ILE:HG13	2.00	0.61
1:A:113:THR:HG22	1:A:115:ILE:HD13	1.81	0.61
1:A:46:THR:HG21	3:A:164:NAP:H5N	1.83	0.60
1:A:139:GLU:OE1	1:A:141:HIS:NE2	2.28	0.59
1:A:16:MET:HG3	1:A:17:GLU:H	1.67	0.59
1:A:12:ARG:HH11	1:A:12:ARG:HB3	1.68	0.59
1:A:146:GLN:HB2	1:A:147:ASN:HD21	1.62	0.58
1:A:12:ARG:CB	1:A:12:ARG:NH1	2.67	0.57
2:A:161:FOL:OE2	2:A:161:FOL:O	2.21	0.57
1:A:46:THR:OG1	1:A:96:GLY:N	2.38	0.57
1:A:45:HIS:CE1	3:A:164:NAP:C5B	2.88	0.57
1:A:23:ASN:O	1:A:24:LEU:HD23	2.06	0.56
1:A:132:ASP:O	1:A:159:ARG:N	2.31	0.56
1:A:133:TRP:CE3	1:A:158:ARG:N	2.74	0.56
1:A:10:VAL:O	1:A:11:ASP:CB	2.54	0.55
1:A:43:GLY:O	1:A:44:ARG:C	2.50	0.55
1:A:80:GLU:O	1:A:83:ALA:N	2.40	0.55
1:A:31:PHE:CE2	2:A:161:FOL:H16	2.42	0.55
1:A:18:ASN:HD22	3:A:164:NAP:H3D	1.72	0.54
1:A:12:ARG:HH11	1:A:12:ARG:CB	2.20	0.54
1:A:65:GLN:HB3	1:A:66:PRO:CD	2.36	0.54
1:A:104:LEU:HD22	1:A:126:PRO:CB	2.38	0.53
1:A:64:SER:O	1:A:76:LYS:HE2	2.08	0.53
1:A:78:VAL:O	1:A:82:ILE:CG1	2.57	0.53
1:A:75:VAL:HG21	1:A:81:ALA:HA	1.91	0.52
1:A:35:THR:O	1:A:36:LEU:C	2.53	0.52
1:A:113:THR:CG2	1:A:115:ILE:HD11	2.38	0.52
1:A:109:LYS:HE2	1:A:111:TYR:OH	2.10	0.52
1:A:80:GLU:O	1:A:83:ALA:CB	2.56	0.52
1:A:158:ARG:O	4:A:212:HOH:O	2.18	0.51
1:A:35:THR:HA	1:A:38:LYS:HD2	1.93	0.51
1:A:69:ASP:OD1	1:A:71:ARG:HB2	2.11	0.51

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:77:SER:O	1:A:80:GLU:HB2	2.11	0.50
1:A:110:LEU:HD12	1:A:156:LEU:HD22	1.94	0.50
1:A:137:PHE:CD2	1:A:155:ILE:HD12	2.46	0.50
1:A:16:MET:HG3	1:A:17:GLU:N	2.27	0.50
1:A:134:GLU:O	1:A:136:VAL:HG13	2.12	0.50
1:A:143:ALA:HA	1:A:147:ASN:O	2.11	0.50
1:A:104:LEU:O	1:A:158:ARG:NH2	2.45	0.49
1:A:40:VAL:HA	1:A:92:MET:O	2.12	0.49
1:A:147:ASN:ND2	1:A:147:ASN:N	2.61	0.49
1:A:74:TRP:C	1:A:75:VAL:CG1	2.86	0.49
1:A:1:MET:HE1	1:A:109:LYS:HD3	1.94	0.49
1:A:38:LYS:O	1:A:57:ARG:HB3	2.13	0.49
1:A:125:PHE:CD1	1:A:126:PRO:HD2	2.48	0.48
1:A:51:GLY:O	1:A:52:ARG:HB3	2.12	0.48
1:A:12:ARG:NH2	1:A:127:ASP:OD2	2.46	0.48
1:A:63:SER:OG	3:A:164:NAP:O1X	2.31	0.48
1:A:74:TRP:O	1:A:75:VAL:HG13	2.13	0.48
1:A:8:LEU:N	1:A:8:LEU:CD1	2.76	0.48
1:A:45:HIS:HD1	3:A:164:NAP:PA	2.37	0.48
1:A:142:ASP:HA	1:A:150:SER:HB3	1.95	0.47
1:A:116:ASP:CG	4:A:305:HOH:O	2.57	0.47
1:A:125:PHE:O	1:A:126:PRO:C	2.58	0.47
1:A:1:MET:HE2	1:A:90:GLU:CD	2.40	0.47
1:A:104:LEU:CD2	1:A:126:PRO:CB	2.83	0.47
1:A:74:TRP:C	1:A:75:VAL:HG13	2.40	0.46
1:A:148:SER:OG	4:A:239:HOH:O	2.03	0.46
1:A:99:VAL:HG23	3:A:164:NAP:O1A	2.16	0.46
1:A:137:PHE:O	1:A:154:GLU:HA	2.15	0.46
1:A:18:ASN:ND2	3:A:164:NAP:H3D	2.29	0.46
1:A:20:MET:C	1:A:22:TRP:H	2.23	0.46
1:A:7:ALA:C	1:A:8:LEU:HD12	2.40	0.46
1:A:86:GLY:O	4:A:209:HOH:O	2.21	0.46
1:A:75:VAL:HG21	1:A:81:ALA:CA	2.46	0.46
1:A:44:ARG:CD	3:A:164:NAP:O3X	2.64	0.46
1:A:110:LEU:CD1	1:A:112:LEU:HD11	2.46	0.45
1:A:143:ALA:O	1:A:144:ASP:HB3	2.16	0.45
1:A:154:GLU:HG2	1:A:155:ILE:N	2.31	0.45
1:A:65:GLN:CB	1:A:66:PRO:CD	2.96	0.44
1:A:61:ILE:N	1:A:61:ILE:CD1	2.79	0.44
1:A:97:GLY:O	1:A:100:TYR:HB2	2.17	0.44
1:A:58:LYS:NZ	1:A:73:THR:HG21	2.33	0.44

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:104:LEU:HB3	1:A:105:PRO:CD	2.41	0.43
1:A:124:HIS:CD2	1:A:124:HIS:N	2.85	0.43
1:A:4:LEU:HD21	1:A:104:LEU:HA	2.00	0.43
1:A:46:THR:O	1:A:49:SER:N	2.51	0.43
1:A:16:MET:C	1:A:17:GLU:O	2.60	0.43
1:A:29:ALA:O	1:A:33:ARG:HB3	2.19	0.43
1:A:42:MET:HG2	1:A:94:ILE:CD1	2.48	0.43
1:A:60:ILE:HA	1:A:73:THR:O	2.19	0.42
1:A:94:ILE:O	3:A:164:NAP:H5N	2.19	0.42
1:A:142:ASP:C	1:A:143:ALA:O	2.56	0.42
1:A:85:CYS:SG	1:A:91:ILE:HG12	2.60	0.42
1:A:63:SER:O	1:A:76:LYS:HA	2.18	0.42
1:A:42:MET:HG2	1:A:94:ILE:CG1	2.50	0.41
1:A:42:MET:SD	1:A:50:ILE:HD12	2.61	0.41
1:A:45:HIS:CE1	3:A:164:NAP:O3B	2.73	0.41
1:A:110:LEU:HD13	1:A:112:LEU:HD11	2.02	0.41
1:A:117:ALA:HB2	1:A:149:HIS:CD2	2.56	0.41
1:A:134:GLU:O	1:A:156:LEU:HA	2.21	0.41

All (2) 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)
4:A:305:HOH:O	4:A:305:HOH:O[4_556]	1.45	0.75
4:A:311:HOH:O	4:A:311:HOH:O[4_556]	1.89	0.31

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	157/159 (99%)	132 (84%)	20 (13%)	5 (3%)	3 4

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	11	ASP
1	A	148	SER
1	A	36	LEU
1	A	21	PRO
1	A	143	ALA

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	126/136 (93%)	104 (82%)	22 (18%)	2 3

All (22) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	4	LEU
1	A	5	ILE
1	A	10	VAL
1	A	12	ARG
1	A	30	TRP
1	A	33	ARG
1	A	42	MET
1	A	59	ASN
1	A	60	ILE
1	A	61	ILE
1	A	75	VAL
1	A	80	GLU
1	A	82	ILE
1	A	87	ASP
1	A	115	ILE
1	A	123	THR
1	A	136	VAL
1	A	138	SER
1	A	142	ASP
1	A	146	GLN

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	148	SER
1	A	156	LEU

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

Mol	Chain	Res	Type
1	A	18	ASN
1	A	124	HIS
1	A	147	ASN
1	A	149	HIS

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 oligosaccharides 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
2	FOL	A	161	-	34,34,34	1.80	10 (29%)	43,47,47	2.68	17 (39%)
3	NAP	A	164	-	50,52,52	3.68	24 (48%)	71,80,80	2.62	19 (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	FOL	A	161	-	-	5/22/22/22	0/3/3/3
3	NAP	A	164	-	-	7/35/67/67	0/5/5/5

All (34) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	164	NAP	O4B-C4B	-11.75	1.18	1.45
3	A	164	NAP	C4N-C3N	11.56	1.56	1.39
3	A	164	NAP	C5N-C4N	8.68	1.53	1.38
3	A	164	NAP	PA-O3	-5.91	1.53	1.59
3	A	164	NAP	C5A-C6A	5.49	1.56	1.41
3	A	164	NAP	O4D-C1D	4.96	1.47	1.40
3	A	164	NAP	C2N-N1N	4.82	1.40	1.35
3	A	164	NAP	C6N-C5N	-4.82	1.28	1.38
3	A	164	NAP	P2B-O2B	-4.78	1.51	1.59
3	A	164	NAP	C4A-N9A	-4.73	1.27	1.37
3	A	164	NAP	C2N-C3N	-3.99	1.32	1.39
3	A	164	NAP	PN-O2N	-3.89	1.37	1.55
3	A	164	NAP	C5A-N7A	3.56	1.45	1.39
3	A	164	NAP	C5A-C4A	-3.53	1.32	1.39
3	A	164	NAP	PN-O5D	3.53	1.73	1.59
2	A	161	FOL	C2-N3	3.52	1.41	1.33
2	A	161	FOL	O4-C4	3.22	1.29	1.23
2	A	161	FOL	C4A-C8A	-3.21	1.33	1.42
2	A	161	FOL	CA-N	3.11	1.52	1.45
3	A	164	NAP	C3N-C7N	-2.97	1.46	1.50
2	A	161	FOL	C7-N8	-2.88	1.28	1.34
2	A	161	FOL	C8A-N1	2.84	1.41	1.38
3	A	164	NAP	O2B-C2B	-2.83	1.34	1.44
2	A	161	FOL	O2-CT	-2.62	1.22	1.30
3	A	164	NAP	C2B-C1B	-2.55	1.46	1.53
3	A	164	NAP	C5D-C4D	2.43	1.58	1.51
2	A	161	FOL	OE1-CD	2.43	1.30	1.22
3	A	164	NAP	O3D-C3D	-2.40	1.37	1.43
3	A	164	NAP	PA-O5B	2.36	1.68	1.59
2	A	161	FOL	C13-C14	-2.30	1.35	1.39
3	A	164	NAP	O2D-C2D	-2.29	1.37	1.43
2	A	161	FOL	O1-CT	2.26	1.28	1.22

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	164	NAP	P2B-O1X	2.17	1.57	1.50
3	A	164	NAP	C8A-N9A	-2.17	1.33	1.37

All (36) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	164	NAP	C5N-C4N-C3N	-12.62	107.96	120.36
3	A	164	NAP	P2B-O2B-C2B	8.64	146.51	123.43
2	A	161	FOL	C6-C7-N8	6.58	129.46	123.14
2	A	161	FOL	CG-CB-CA	6.54	125.22	113.16
3	A	164	NAP	C4A-N9A-C8A	6.30	112.36	105.74
2	A	161	FOL	C7-C6-N5	-6.13	116.89	120.87
3	A	164	NAP	C6N-N1N-C2N	-5.15	117.50	121.88
2	A	161	FOL	OE2-CD-CG	5.01	129.83	114.00
3	A	164	NAP	O7N-C7N-N7N	-4.37	116.31	122.62
2	A	161	FOL	CB-CG-CD	4.31	123.98	112.49
2	A	161	FOL	OE1-CD-CG	-4.09	110.13	123.09
3	A	164	NAP	O3X-P2B-O2B	3.91	121.07	105.85
3	A	164	NAP	C5N-C6N-N1N	3.58	125.27	120.38
2	A	161	FOL	C15-C16-C11	-3.53	117.03	120.80
2	A	161	FOL	C4A-C8A-N1	3.49	124.39	120.13
3	A	164	NAP	N3A-C2A-N1A	3.48	133.86	128.58
3	A	164	NAP	C2N-C3N-C4N	3.45	122.28	118.26
2	A	161	FOL	C8A-C4A-C4	-3.22	117.47	119.56
2	A	161	FOL	NA2-C2-N1	3.04	123.17	116.77
3	A	164	NAP	O2N-PN-O1N	2.99	126.37	112.44
3	A	164	NAP	O2B-C2B-C3B	2.91	122.11	111.68
3	A	164	NAP	N9A-C8A-N7A	-2.77	110.01	113.94
3	A	164	NAP	C6N-C5N-C4N	2.76	123.42	119.45
3	A	164	NAP	C4B-O4B-C1B	2.69	115.40	109.47
2	A	161	FOL	N1-C2-N3	-2.65	118.48	123.32
3	A	164	NAP	O2N-PN-O3	2.61	114.32	107.27
2	A	161	FOL	CB-CA-N	-2.59	105.78	110.91
3	A	164	NAP	O3D-C3D-C4D	2.54	118.37	111.08
2	A	161	FOL	C12-C13-C14	-2.51	117.42	120.30
2	A	161	FOL	O-C-C11	2.43	125.72	120.90
3	A	164	NAP	C2A-N1A-C6A	-2.41	114.77	118.73
3	A	164	NAP	O7N-C7N-C3N	2.33	122.45	119.60
2	A	161	FOL	O4-C4-N3	2.14	123.48	120.23
2	A	161	FOL	C9-C6-N5	2.12	120.56	116.56
2	A	161	FOL	C15-C14-C13	2.11	121.85	119.04
3	A	164	NAP	C3N-C7N-N7N	2.06	120.28	117.74

There are no chirality outliers.

All (12) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	164	NAP	C3B-C2B-O2B-P2B
3	A	164	NAP	PA-O3-PN-O5D
3	A	164	NAP	O4D-C1D-N1N-C2N
3	A	164	NAP	O4D-C1D-N1N-C6N
2	A	161	FOL	N-CA-CB-CG
2	A	161	FOL	CA-CB-CG-CD
3	A	164	NAP	C3B-C4B-C5B-O5B
2	A	161	FOL	CT-CA-CB-CG
3	A	164	NAP	O4B-C4B-C5B-O5B
2	A	161	FOL	OE1-CD-CG-CB
2	A	161	FOL	OE2-CD-CG-CB
3	A	164	NAP	C2B-O2B-P2B-O2X

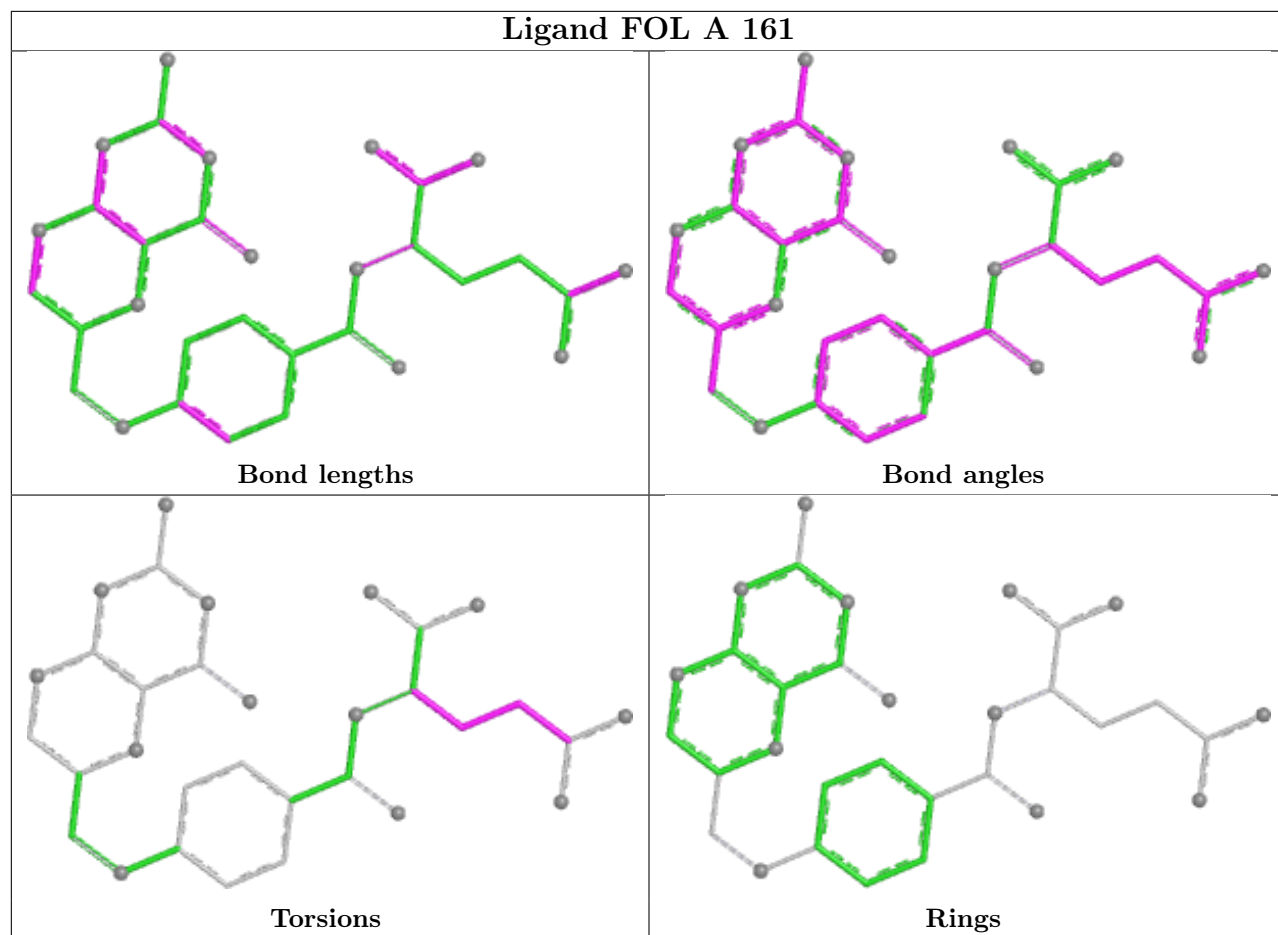
There are no ring outliers.

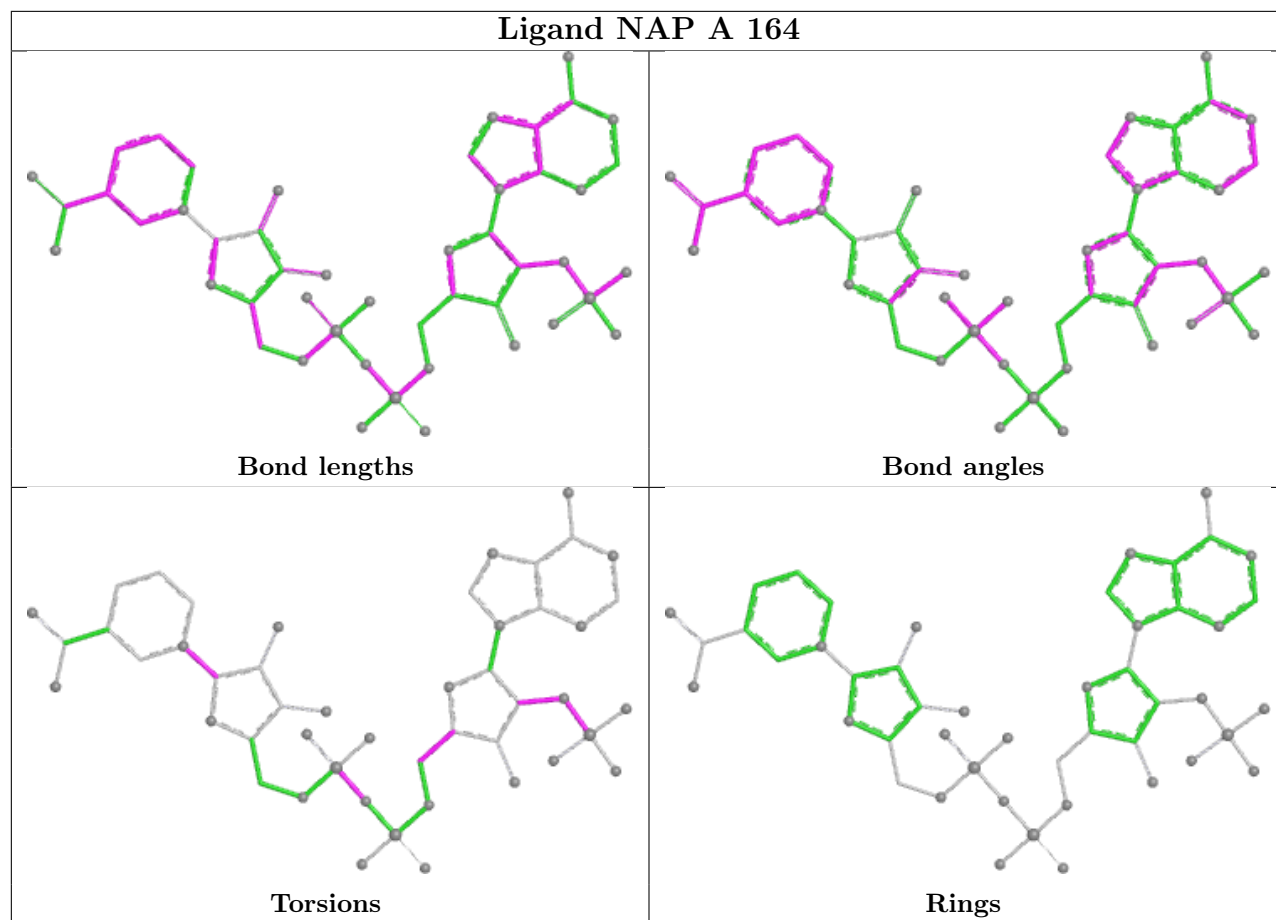
2 monomers are involved in 18 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	161	FOL	2	0
3	A	164	NAP	16	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.

Ligand FOL A 161





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

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.