



# Full wwPDB X-ray Structure Validation Report

Feb 27, 2014 – 02:24 PM GMT

PDB ID : 2W3M  
Title : HUMAN DIHYDROFOLATE REDUCTASE COMPLEXED WITH NADPH  
AND FOLATE  
Authors : Leung, A.K.W.; Reynolds, R.C.; Borhani, D.W.  
Deposited on : 2008-11-13  
Resolution : 1.60 Å(reported)

This is a full wwPDB validation report for a publicly released PDB entry.  
We welcome your comments at [validation@mail.wwpdb.org](mailto:validation@mail.wwpdb.org)  
A user guide is available at <http://wwpdb.org/ValidationPDFNotes.html>

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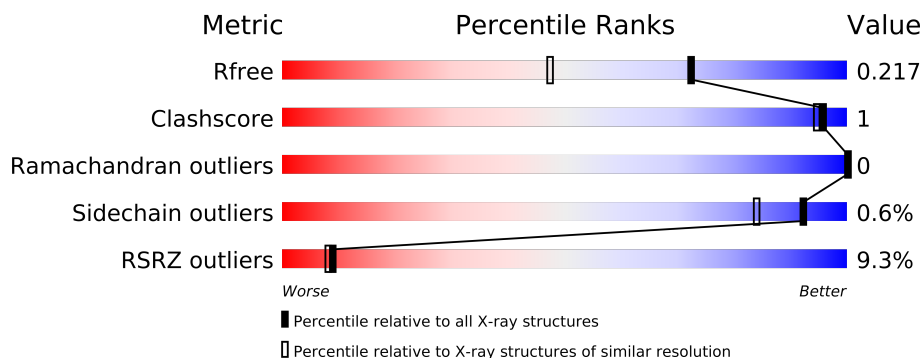
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.15 2013  
Xtriage (Phenix) : dev-1323  
EDS : stable22639  
Percentile statistics : 21963  
Refmac : 5.8.0049  
CCP4 : 6.3.0 (Settle)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)  
Validation Pipeline (wwPDB-VP) : stable22683

# 1 Overall quality at a glance



The reported resolution of this entry is 1.60 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))
$R_{free}$	66092	1872 (1.60-1.60)
Clashscore	79885	2199 (1.60-1.60)
Ramachandran outliers	78287	2126 (1.60-1.60)
Sidechain outliers	78261	2125 (1.60-1.60)
RSRZ outliers	66119	1872 (1.60-1.60)

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 on the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	187	
1	B	187	

## 2 Entry composition i

There are 4 unique types of molecules in this entry. The entry contains 3787 atoms, of which 0 are hydrogen and 0 are deuterium.

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.

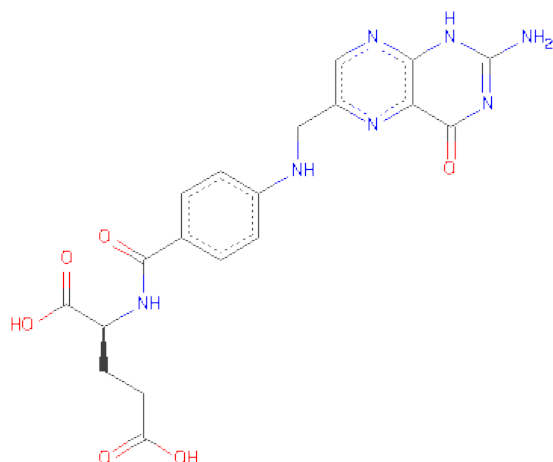
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	186	Total	C	N	O	S	0	13	0
			1573	1010	261	291	11			
1	B	186	Total	C	N	O	S	0	9	0
			1560	1002	262	288	8			

- Molecule 2 is NADPH DIHYDRO-NICOTINAMIDE-ADENINE-DINUCLEOTIDEPHOSPHATE (three-letter code: NDP) (formula:  $C_{21}H_{30}N_7O_{17}P_3$ ).



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

- Molecule 3 is FOLIC ACID (three-letter code: FOL) (formula:  $C_{19}H_{19}N_7O_6$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	N	O	0	0
			32	19	7	6		
3	B	1	Total	C	N	O	0	0
			32	19	7	6		

- Molecule 4 is water.

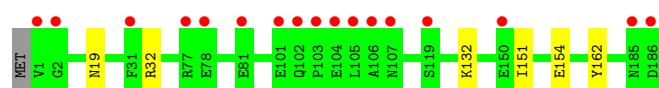
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	238	Total	O	0	0
			238	238		
4	B	256	Total	O	0	0
			256	256		

### 3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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.

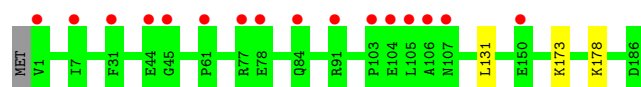
- Molecule 1: DIHYDROFOLATE REDUCTASE

Chain A: 



- Molecule 1: DIHYDROFOLATE REDUCTASE

Chain B: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	88.55Å 94.27Å 96.68Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	10.70 – 1.60 10.68 – 1.60	Depositor EDS
% Data completeness (in resolution range)	98.1 (10.70-1.60) 98.5 (10.68-1.60)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.93 (at 1.60Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.167 , 0.208 0.173 , 0.217	Depositor DCC
$R_{free}$ test set	2659 reflections (5.06%)	DCC
Wilson B-factor (Å <sup>2</sup> )	17.3	Xtriage
Anisotropy	0.071	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.45 , 62.3	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Outliers	0 of 52591 reflections	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	3787	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	19.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.58% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

## 5 Model quality

### 5.1 Standard geometry

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

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	0.65	0/1608	0.74	1/2172 (0.0%)
1	B	0.63	0/1595	0.70	0/2151
All	All	0.64	0/3203	0.72	1/4323 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	32	ARG	NE-CZ-NH1	6.18	123.39	120.30

There are no chirality outliers.

There are no planarity outliers.

### 5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	1573	0	0	3	0
1	B	1560	0	0	2	0
2	A	48	0	0	0	0
2	B	48	0	0	0	0
3	A	32	0	0	0	0
3	B	32	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	A	238	0	0	1	0
4	B	256	0	0	1	0
All	All	3787	0	0	4	0

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 1.

All (4) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:132:LYS:NZ	1:A:162:TYR:OH	2.41	0.53
1:B:173[A]:LYS:NZ	4:B:2233:HOH:O	2.44	0.49
1:A:19:ASN:OD1	1:B:178[A]:LYS:NZ	2.46	0.48
1:A:151:ILE:N	4:A:2183:HOH:O	2.53	0.42

There are no symmetry-related clashes.

## 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	197/187 (105%)	196 (100%)	1 (0%)	0	100	100
1	B	194/187 (104%)	192 (99%)	2 (1%)	0	100	100
All	All	391/374 (104%)	388 (99%)	3 (1%)	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	171/169 (101%)	170 (99%)	1 (1%)	92	84
1	B	172/169 (102%)	171 (99%)	1 (1%)	92	84
All	All	343/338 (102%)	341 (99%)	2 (1%)	92	84

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	154	GLU
1	B	131	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 5.3.3 RNA ⓘ

There are no RNA chains 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 ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

4 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	NDP	A	1187	-	52,52,52	1.19	2 (3%)	80,80,80	1.67	10 (12%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
3	FOL	A	1188	-	34,34,34	2.18	6 (17%)	45,47,47	1.51	9 (20%)
2	NDP	B	1187	-	52,52,52	1.37	6 (11%)	80,80,80	1.70	11 (13%)
3	FOL	B	1188	-	34,34,34	2.17	5 (14%)	45,47,47	1.47	8 (17%)

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	NDP	A	1187	-	-	0/35/77/77	0/3/5/5
3	FOL	A	1188	-	-	0/22/22/22	0/1/3/3
2	NDP	B	1187	-	-	0/35/77/77	0/3/5/5
3	FOL	B	1188	-	-	0/22/22/22	0/1/3/3

All (19) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	1188	FOL	O-C	9.48	1.42	1.23
3	A	1188	FOL	O-C	8.77	1.40	1.23
2	B	1187	NDP	O7N-C7N	5.27	1.38	1.24
2	A	1187	NDP	O7N-C7N	5.24	1.38	1.24
3	A	1188	FOL	C2-N3	4.96	1.39	1.33
3	B	1188	FOL	C2-N3	4.64	1.39	1.33
3	A	1188	FOL	C7-N8	3.85	1.38	1.31
2	B	1187	NDP	C2A-N3A	3.82	1.39	1.32
3	B	1188	FOL	C7-N8	3.79	1.38	1.31
3	A	1188	FOL	C8A-N8	3.46	1.39	1.34
2	A	1187	NDP	C2A-N3A	3.06	1.38	1.32
2	B	1187	NDP	C2A-N1A	3.05	1.39	1.33
3	A	1188	FOL	C6-N5	2.78	1.38	1.32
2	B	1187	NDP	PN-O3	2.72	1.64	1.59
3	B	1188	FOL	C6-N5	2.71	1.38	1.32
3	A	1188	FOL	C2-NA2	2.52	1.36	1.32
2	B	1187	NDP	C6N-C5N	2.52	1.38	1.33
3	B	1188	FOL	C8A-N8	2.42	1.37	1.34
2	B	1187	NDP	C2N-C3N	2.14	1.38	1.34

All (38) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	1187	NDP	N3A-C2A-N1A	-10.90	119.59	128.71
2	B	1187	NDP	N3A-C2A-N1A	-10.43	119.99	128.71
2	B	1187	NDP	O4B-C1B-C2B	-4.23	102.99	106.95
3	A	1188	FOL	C4-N3-C2	4.09	121.33	116.91
3	B	1188	FOL	C4-N3-C2	3.99	121.22	116.91
2	B	1187	NDP	N3A-C4A-N9A	3.96	132.58	125.43
3	B	1188	FOL	C6-C7-N8	-3.34	119.64	123.16
3	B	1188	FOL	OE2-CD-OE1	-3.20	115.16	123.30
3	B	1188	FOL	OE2-CD-CG	3.00	124.81	114.22
3	B	1188	FOL	CB-CA-N	2.90	116.37	110.83
2	A	1187	NDP	N3A-C4A-N9A	2.71	130.32	125.43
2	A	1187	NDP	C1D-N1N-C2N	-2.60	116.60	121.02
2	A	1187	NDP	C6N-N1N-C2N	2.57	122.81	119.44
2	A	1187	NDP	C4N-C3N-C2N	-2.57	118.55	121.68
3	A	1188	FOL	C9-C6-N5	2.56	121.52	116.79
3	A	1188	FOL	C4-C4A-C8A	2.49	120.04	116.23
3	A	1188	FOL	CB-CA-N	2.44	115.48	110.83
3	A	1188	FOL	NA2-C2-N3	2.41	123.56	120.30
3	A	1188	FOL	CB-CG-CD	-2.39	107.07	112.88
3	A	1188	FOL	OE2-CD-CG	2.39	122.66	114.22
2	B	1187	NDP	O7N-C7N-C3N	-2.37	116.06	120.51
2	A	1187	NDP	O7N-C7N-C3N	-2.36	116.08	120.51
2	A	1187	NDP	C3N-C7N-N7N	2.32	121.94	117.48
2	B	1187	NDP	O2A-PA-O3	2.31	116.12	105.14
2	B	1187	NDP	O3X-P2B-O2X	2.31	116.60	107.61
2	B	1187	NDP	C5A-C4A-N3A	-2.30	120.68	125.70
3	A	1188	FOL	C6-C7-N8	-2.26	120.78	123.16
3	B	1188	FOL	C4-C4A-C8A	2.25	119.68	116.23
2	B	1187	NDP	N7A-C8A-N9A	-2.24	108.02	114.36
2	A	1187	NDP	N7A-C8A-N9A	-2.23	108.05	114.36
2	A	1187	NDP	C1B-N9A-C4A	-2.20	122.84	126.64
2	B	1187	NDP	O2B-C2B-C1B	-2.17	102.32	110.36
3	B	1188	FOL	C7-N8-C8A	2.16	119.68	116.62
3	B	1188	FOL	C9-C6-N5	2.12	120.71	116.79
2	B	1187	NDP	C4A-C5A-N7A	-2.09	107.73	109.52
2	A	1187	NDP	O2A-PA-O3	2.06	114.92	105.14
3	A	1188	FOL	OE2-CD-OE1	-2.01	118.18	123.30
2	B	1187	NDP	C8A-N7A-C5A	2.00	109.79	103.58

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

## 5.7 Other polymers ⓘ

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 ⓘ

### 6.1 Protein, DNA and RNA chains ⓘ

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	186/187 (99%)	0.64	17 (9%) 9 8	9, 16, 26, 32	0
1	B	186/187 (99%)	0.59	16 (8%) 11 10	11, 17, 25, 30	0
All	All	372/374 (99%)	0.62	33 (8%) 9 9	9, 16, 26, 32	0

All (33) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	103	PRO	5.5
1	A	102	GLN	4.6
1	A	186	ASP	4.0
1	A	101	GLU	3.8
1	A	107	ASN	3.7
1	A	106	ALA	3.7
1	A	150	GLU	3.4
1	A	1	VAL	3.2
1	B	78	GLU	3.1
1	A	185	ASN	2.7
1	B	1	VAL	2.7
1	B	31	PHE	2.7
1	B	107	ASN	2.6
1	B	84	GLN	2.6
1	A	77	ARG	2.5
1	B	91	ARG	2.5
1	A	105	LEU	2.5
1	B	105	LEU	2.4
1	B	7	ILE	2.4
1	B	77	ARG	2.3
1	A	104	GLU	2.3
1	B	45	GLY	2.3
1	A	31	PHE	2.2
1	A	81	GLU	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	2	GLY	2.2
1	B	103	PRO	2.2
1	A	78	GLU	2.1
1	B	106	ALA	2.1
1	A	119	SER	2.1
1	B	61	PRO	2.1
1	B	104	GLU	2.0
1	B	150	GLU	2.0
1	B	44	GLU	2.0

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

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

## 6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 6.4 Ligands ⓘ

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. The B-factors column lists the minimum, median, 95<sup>th</sup> 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	RSR	LLDF	B-factors(Å <sup>2</sup> )	Q < 0.9
3	FOL	A	1188	32/32	0.15	1.01	18,22,29,33	32
3	FOL	B	1188	32/32	0.14	0.40	18,23,27,31	32
2	NDP	A	1187	48/48	0.13	-0.15	10,14,17,21	48
2	NDP	B	1187	48/48	0.13	-0.23	12,15,23,24	48

## 6.5 Other polymers ⓘ

There are no such residues in this entry.