wwPDB X-ray Structure Validation Summary Report (i)

Feb 1, 2016 – 12:43 PM GMT

PDB ID	:	3RUH
Title	:	Alternative analogs as viable substrates of UDP-hexose 4-epimerases
Authors	:	Bhatt, V.S.; Guan, W.; Wang, P.G.
Deposited on	:	2011-05-05
Resolution	:	2.88 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
http://wwpdb.org/validation/2016/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

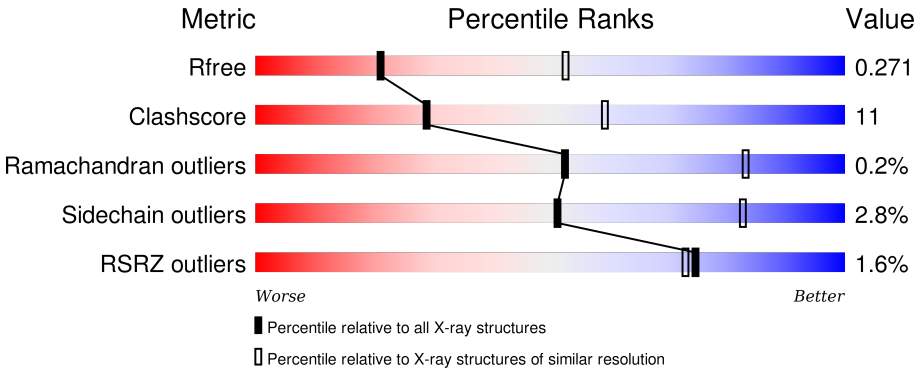
MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk26865

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 2.88 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}	91344	1945 (2.90-2.86)
Clashscore	102246	2202 (2.90-2.86)
Ramachandran outliers	100387	2149 (2.90-2.86)
Sidechain outliers	100360	2152 (2.90-2.86)
RSRZ outliers	91569	1950 (2.90-2.86)

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 on the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria. 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	351	72% 22%
1	B	351	71% 23%
1	C	351	72% 23%
1	D	351	69% 25%

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 11113 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 WbgU.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	336	Total	C	N	O	S	0	0	0
			2681	1712	459	502	8			
1	B	336	Total	C	N	O	S	0	0	0
			2681	1712	459	502	8			
1	C	336	Total	C	N	O	S	0	0	0
			2681	1712	459	502	8			
1	D	336	Total	C	N	O	S	0	0	0
			2681	1712	459	502	8			

There are 24 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-8	HIS	-	EXPRESSION TAG	UNP Q7BJX9
A	-7	HIS	-	EXPRESSION TAG	UNP Q7BJX9
A	-6	HIS	-	EXPRESSION TAG	UNP Q7BJX9
A	-5	HIS	-	EXPRESSION TAG	UNP Q7BJX9
A	-4	HIS	-	EXPRESSION TAG	UNP Q7BJX9
A	-3	HIS	-	EXPRESSION TAG	UNP Q7BJX9
B	-8	HIS	-	EXPRESSION TAG	UNP Q7BJX9
B	-7	HIS	-	EXPRESSION TAG	UNP Q7BJX9
B	-6	HIS	-	EXPRESSION TAG	UNP Q7BJX9
B	-5	HIS	-	EXPRESSION TAG	UNP Q7BJX9
B	-4	HIS	-	EXPRESSION TAG	UNP Q7BJX9
B	-3	HIS	-	EXPRESSION TAG	UNP Q7BJX9
C	-8	HIS	-	EXPRESSION TAG	UNP Q7BJX9
C	-7	HIS	-	EXPRESSION TAG	UNP Q7BJX9
C	-6	HIS	-	EXPRESSION TAG	UNP Q7BJX9
C	-5	HIS	-	EXPRESSION TAG	UNP Q7BJX9
C	-4	HIS	-	EXPRESSION TAG	UNP Q7BJX9
C	-3	HIS	-	EXPRESSION TAG	UNP Q7BJX9
D	-8	HIS	-	EXPRESSION TAG	UNP Q7BJX9
D	-7	HIS	-	EXPRESSION TAG	UNP Q7BJX9
D	-6	HIS	-	EXPRESSION TAG	UNP Q7BJX9

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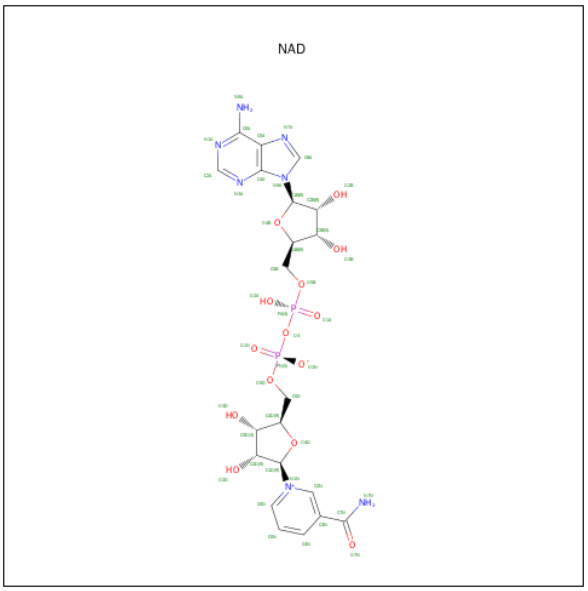
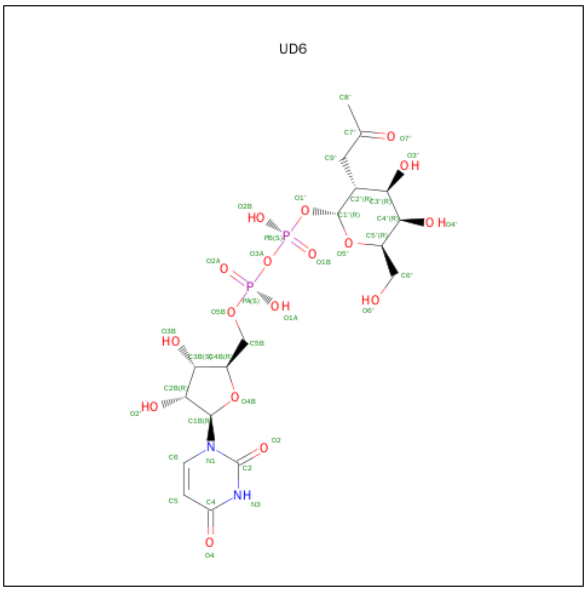
Chain	Residue	Modelled	Actual	Comment	Reference
D	-5	HIS	-	EXPRESSION TAG	UNP Q7BJX9
D	-4	HIS	-	EXPRESSION TAG	UNP Q7BJX9
D	-3	HIS	-	EXPRESSION TAG	UNP Q7BJX9

- Molecule 2 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (three-letter code: NAD) (formula: $C_{21}H_{27}N_7O_{14}P_2$).



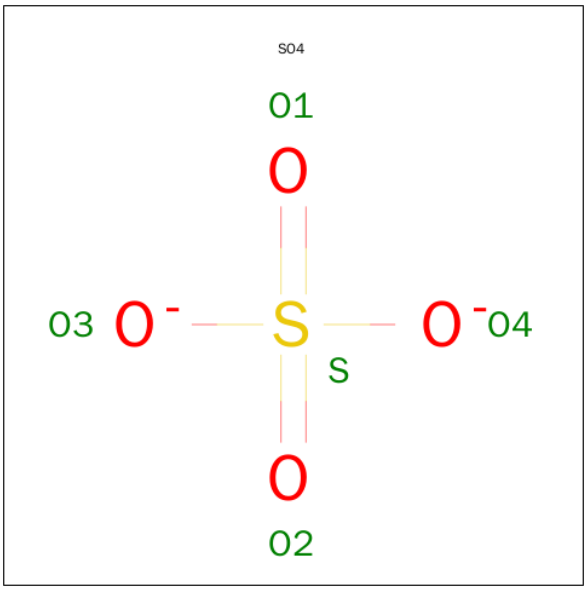
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
2	B	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
2	C	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
2	D	1	Total	C	N	O	P	0	0
			44	21	7	14	2		

- Molecule 3 is [[(2R,3S,4R,5R)-5-[2,4-BIS(OXIDANYLIDENE)PYRIMIDIN-1-YL]-3,4-BIS(OXIDANYL)OXOLAN-2-YL]METHOXY-OXIDANYL-PHOSPHORYL] [(2R,3R,4R,5R,6R)-6-(HYDROXYMETHYL)-4,5-BIS(OXIDANYL)-3-(2-OXIDANYLIDENEPROPYL)OXAN-2-YL] HYDROGEN PHOSPHATE (three-letter code: UD6) (formula: $C_{18}H_{28}N_2O_{17}P_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			39	18	2	17	2		
3	B	1	Total	C	N	O	P	0	0
			39	18	2	17	2		
3	C	1	Total	C	N	O	P	0	0
			39	18	2	17	2		
3	D	1	Total	C	N	O	P	0	0
			39	18	2	17	2		

- Molecule 4 is SULFATE ION (three-letter code: SO4) (formula: O_4S).



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

- Molecule 5 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	1	Total Na 1 1	0	0

- Molecule 6 is water.

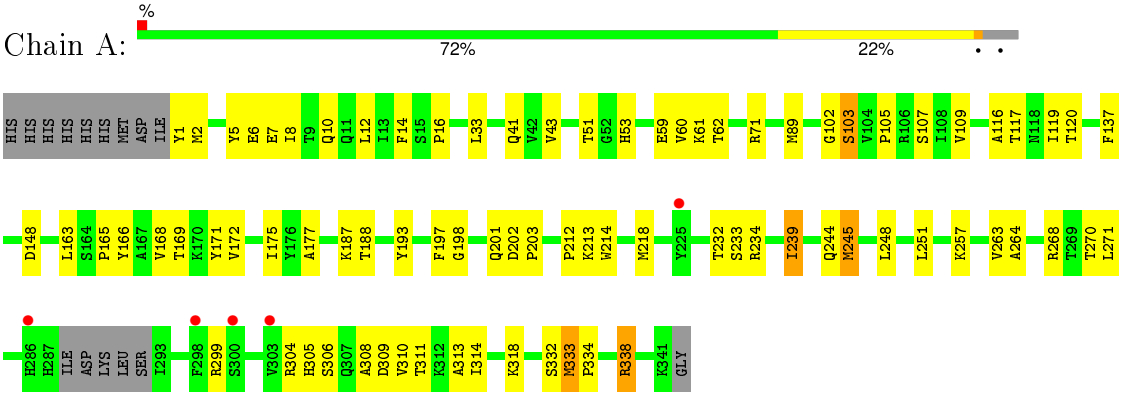
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	7	Total O 7 7	0	0
6	B	10	Total O 10 10	0	0
6	C	13	Total O 13 13	0	0
6	D	11	Total O 11 11	0	0

3 Residue-property plots (i)

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.

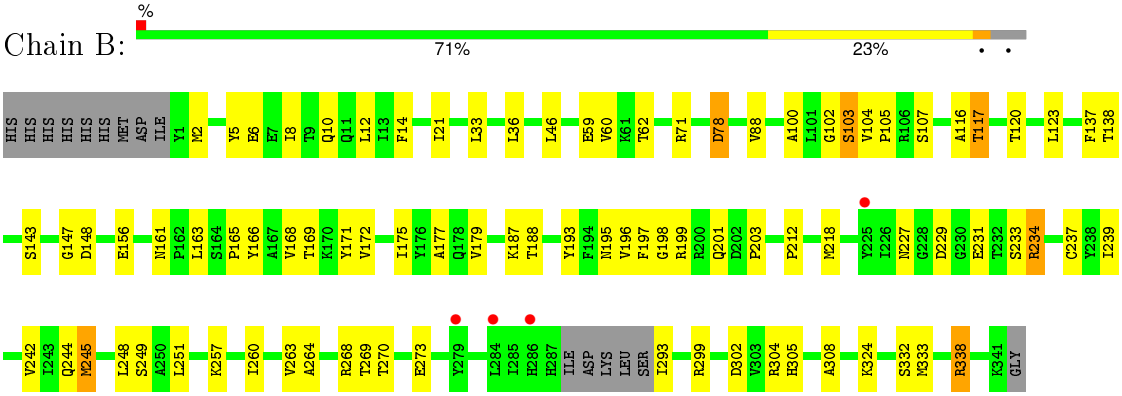
- Molecule 1: WbgU

Chain A:



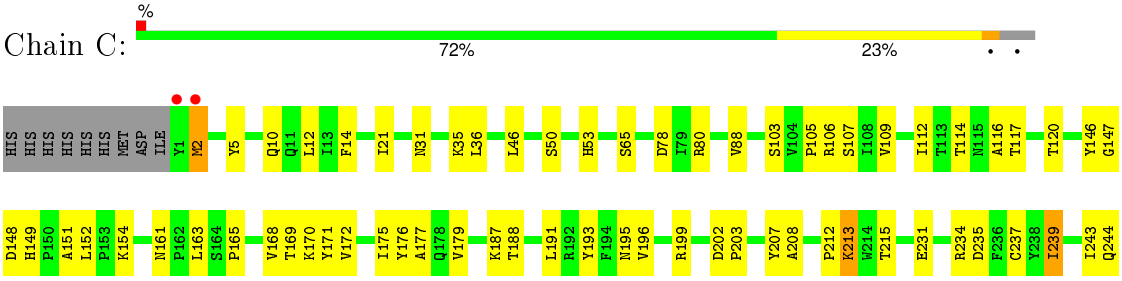
- Molecule 1: WbgU

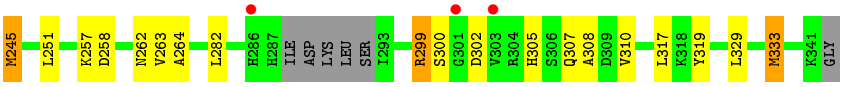
Chain B:



- Molecule 1: WbgU

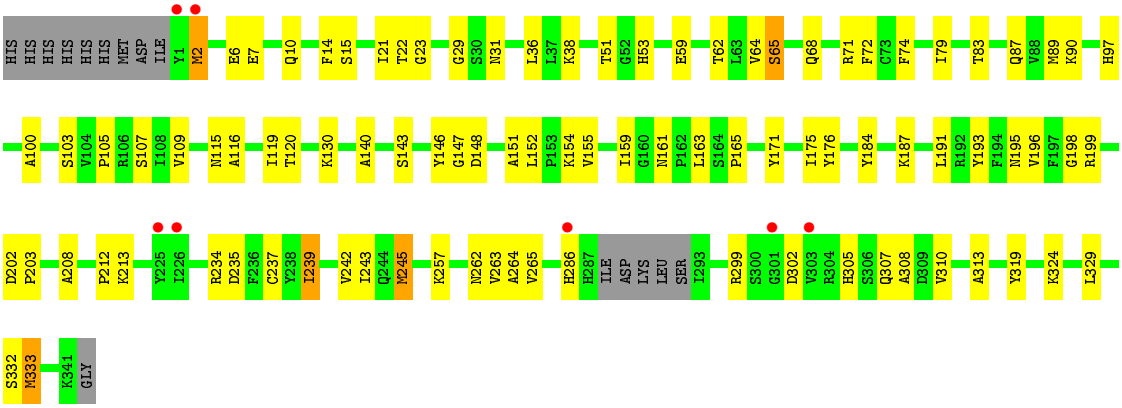
Chain C:





- Molecule 1: WbgU

Chain D:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 32	Depositor
Cell constants a, b, c, α, β, γ	76.61Å 76.61Å 220.60Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	73.53 – 2.88 30.24 – 2.88	Depositor EDS
% Data completeness (in resolution range)	98.2 (73.53-2.88) 98.3 (30.24-2.88)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.46 (at 2.90Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.210 , 0.268 0.210 , 0.271	Depositor DCC
R_{free} test set	1622 reflections (5.31%)	DCC
Wilson B-factor (Å^2)	36.7	Xtriage
Anisotropy	0.085	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.37 , 4.8	EDS
Estimated twinning fraction	0.049 for -h,-k,l 0.457 for h,-h-k,-l 0.050 for -k,-h,-l	Xtriage
L-test for twinning[2]	$< \|L\| > = 0.45$, $< L^2 > = 0.27$	Xtriage
Outliers	0 of 32326 reflections	Xtriage
F_o,F_c correlation	0.90	EDS
Total number of atoms	11113	wwPDB-VP
Average B, all atoms (Å^2)	36.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.25% 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, 0.375 respectively for untwinned datasets, and 0.333, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: NA, UD6, SO4, NAD

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	0.49	5/2739 (0.2%)	0.55	0/3717
1	B	0.48	4/2739 (0.1%)	0.55	0/3717
1	C	0.48	3/2739 (0.1%)	0.56	0/3717
1	D	0.48	2/2739 (0.1%)	0.56	0/3717
All	All	0.48	14/10956 (0.1%)	0.56	0/14868

The worst 5 of 14 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	D	2	MET	CG-SD	8.12	2.02	1.81
1	C	2	MET	CG-SD	7.84	2.01	1.81
1	A	333	MET	CG-SD	6.05	1.96	1.81
1	B	333	MET	CG-SD	5.91	1.96	1.81
1	A	2	MET	CG-SD	5.58	1.95	1.81

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2681	0	2658	64	0
1	B	2681	0	2658	64	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	C	2681	0	2658	56	0
1	D	2681	0	2658	59	0
2	A	44	0	26	11	0
2	B	44	0	26	5	0
2	C	44	0	26	8	0
2	D	44	0	26	6	0
3	A	39	0	26	4	0
3	B	39	0	26	4	0
3	C	39	0	26	5	0
3	D	39	0	26	5	0
4	A	15	0	0	0	0
5	A	1	0	0	0	0
6	A	7	0	0	1	0
6	B	10	0	0	0	0
6	C	13	0	0	1	0
6	D	11	0	0	0	0
All	All	11113	0	10840	250	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 11.

The worst 5 of 250 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:C:2:MET:SD	1:C:2:MET:CG	2.01	1.49
1:D:2:MET:CG	1:D:2:MET:SD	2.02	1.47
2:A:343:NAD:C4N	3:A:344:UD6:H4'	1.80	1.11
2:C:343:NAD:C4N	3:C:344:UD6:H4'	1.88	1.03
1:D:245:MET:HG2	1:D:263:VAL:HG22	1.47	0.95

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	332/351 (95%)	312 (94%)	19 (6%)	1 (0%)	46 78
1	B	332/351 (95%)	310 (93%)	21 (6%)	1 (0%)	46 78
1	C	332/351 (95%)	314 (95%)	18 (5%)	0	100 100
1	D	332/351 (95%)	316 (95%)	15 (4%)	1 (0%)	46 78
All	All	1328/1404 (95%)	1252 (94%)	73 (6%)	3 (0%)	52 83

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	103	SER
1	A	103	SER
1	D	286	HIS

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	290/304 (95%)	283 (98%)	7 (2%)	57 85
1	B	290/304 (95%)	281 (97%)	9 (3%)	47 80
1	C	290/304 (95%)	284 (98%)	6 (2%)	61 87
1	D	290/304 (95%)	280 (97%)	10 (3%)	44 78
All	All	1160/1216 (95%)	1128 (97%)	32 (3%)	51 83

5 of 32 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	324	LYS
1	C	176	TYR
1	D	199	ARG
1	C	65	SER
1	C	199	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	178	GLN
1	D	149	HIS
1	C	149	HIS
1	A	272	ASN
1	C	287	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 carbohydrates in this entry.

5.6 Ligand geometry (i)

Of 12 ligands modelled in this entry, 1 is monoatomic - leaving 11 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	$\#\|Z\| > 2$
2	NAD	A	343	-	38,48,48	1.25	4 (10%)	47,73,73	1.92	6 (12%)
3	UD6	A	344	-	32,41,41	1.96	6 (18%)	41,62,62	1.61	5 (12%)
4	SO4	A	345	-	4,4,4	0.30	0	6,6,6	0.14	0
4	SO4	A	346	-	4,4,4	0.34	0	6,6,6	0.07	0
4	SO4	A	347	-	4,4,4	0.14	0	6,6,6	0.15	0
2	NAD	B	343	-	38,48,48	1.02	3 (7%)	47,73,73	1.81	7 (14%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
3	UD6	B	344	-	32,41,41	1.88	4 (12%)	41,62,62	1.37	2 (4%)
2	NAD	C	343	-	38,48,48	1.00	3 (7%)	47,73,73	1.92	8 (17%)
3	UD6	C	344	-	32,41,41	1.84	4 (12%)	41,62,62	1.51	3 (7%)
2	NAD	D	343	-	38,48,48	0.92	3 (7%)	47,73,73	2.01	8 (17%)
3	UD6	D	344	-	32,41,41	1.82	3 (9%)	41,62,62	1.62	5 (12%)

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	NAD	A	343	-	-	0/22/62/62	0/5/5/5
3	UD6	A	344	-	-	0/23/63/63	0/3/3/3
4	SO4	A	345	-	-	0/0/0/0	0/0/0/0
4	SO4	A	346	-	-	0/0/0/0	0/0/0/0
4	SO4	A	347	-	-	0/0/0/0	0/0/0/0
2	NAD	B	343	-	-	0/22/62/62	0/5/5/5
3	UD6	B	344	-	-	0/23/63/63	0/3/3/3
2	NAD	C	343	-	-	0/22/62/62	0/5/5/5
3	UD6	C	344	-	-	0/23/63/63	0/3/3/3
2	NAD	D	343	-	-	0/22/62/62	0/5/5/5
3	UD6	D	344	-	-	0/23/63/63	0/3/3/3

The worst 5 of 30 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	344	UD6	C9'-C7'	-7.46	1.39	1.51
3	A	344	UD6	C9'-C7'	-7.35	1.39	1.51
3	C	344	UD6	C9'-C7'	-7.35	1.39	1.51
3	D	344	UD6	C9'-C7'	-7.07	1.40	1.51
2	A	343	NAD	O5D-C5D	-2.22	1.35	1.44

The worst 5 of 44 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	D	343	NAD	N3A-C2A-N1A	-9.91	121.31	128.89
2	C	343	NAD	N3A-C2A-N1A	-9.62	121.53	128.89
2	A	343	NAD	N3A-C2A-N1A	-9.29	121.78	128.89
2	B	343	NAD	N3A-C2A-N1A	-9.29	121.78	128.89
2	A	343	NAD	C4B-O4B-C1B	-5.41	103.78	109.72

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

8 monomers are involved in 34 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	343	NAD	11	0
3	A	344	UD6	4	0
2	B	343	NAD	5	0
3	B	344	UD6	4	0
2	C	343	NAD	8	0
3	C	344	UD6	5	0
2	D	343	NAD	6	0
3	D	344	UD6	5	0

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^{th} 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	336/351 (95%)	-0.00	5 (1%)	76 74	16, 31, 70, 91	0
1	B	336/351 (95%)	0.02	4 (1%)	81 79	16, 31, 69, 93	0
1	C	336/351 (95%)	0.04	5 (1%)	76 74	18, 33, 60, 81	0
1	D	336/351 (95%)	0.07	7 (2%)	67 63	17, 32, 60, 81	0
All	All	1344/1404 (95%)	0.03	21 (1%)	74 73	16, 32, 67, 93	0

The worst 5 of 21 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	286	HIS	7.1
1	D	1	TYR	6.9
1	D	2	MET	6.0
1	C	2	MET	5.8
1	C	1	TYR	4.9

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^{th} 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	LLDF	B-factors(Å^2)	Q<0.9
2	NAD	C	343	44/44	0.96	0.20	0.11	21,27,37,38	0
2	NAD	A	343	44/44	0.97	0.18	0.02	21,24,39,40	0
2	NAD	B	343	44/44	0.96	0.18	-0.18	20,25,37,39	0
3	UD6	B	344	39/39	0.91	0.20	-0.29	25,37,58,60	14
5	NA	A	348	1/1	0.95	0.21	-0.35	22,22,22,22	0
2	NAD	D	343	44/44	0.96	0.17	-0.35	22,28,38,41	0
3	UD6	D	344	39/39	0.95	0.19	-0.54	29,35,44,46	14
3	UD6	A	344	39/39	0.94	0.17	-0.73	27,38,57,59	14
3	UD6	C	344	39/39	0.95	0.17	-0.78	28,33,42,44	14
4	SO4	A	346	5/5	0.99	0.15	-1.73	44,45,45,45	0
4	SO4	A	345	5/5	0.98	0.14	-2.24	38,38,38,39	0
4	SO4	A	347	5/5	0.84	0.22	-	77,77,77,77	0

6.5 Other polymers (i)

There are no such residues in this entry.