



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 12, 2026 – 06:28 AM UTC

PDB ID : 4O9G / pdb_00004o9g
Title : Crystal structure of the H51N mutant of the 3,4-ketoisomerase QdtA from *Thermoanaerobacterium thermosaccharolyticum* in complex with TDP-4-keto-6-deoxyglucose
Authors : Thoden, J.B.; Holden, H.M.
Deposited on : 2014-01-02
Resolution : 1.90 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	:	FAILED
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	FAILED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

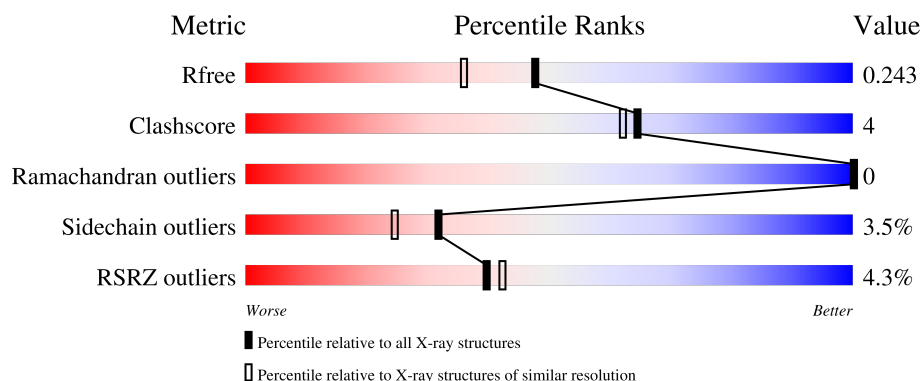
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.90 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}	180053	7789 (1.90-1.90)
Clashscore	190562	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)
RSRZ outliers	180081	7790 (1.90-1.90)

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 $\leq 5\%$. 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	144	3% 88% 8% • •
1	B	144	6% 81% 12% • •

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 2588 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 QdtA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	138	Total	C	N	O	S	0	1	0
			1158	761	183	210	4			
1	B	138	Total	C	N	O	S	0	1	0
			1158	761	183	210	4			

There are 26 discrepancies between the modelled and reference sequences:

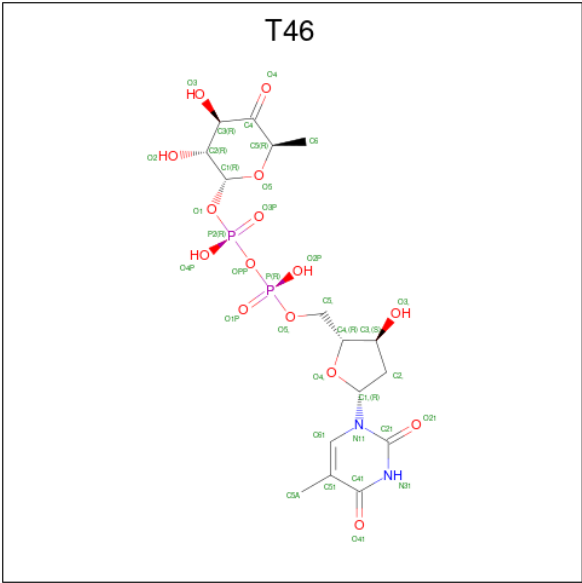
Chain	Residue	Modelled	Actual	Comment	Reference
A	51	ASN	HIS	engineered mutation	UNP Q6TFC5
A	52	SER	ALA	SEE REMARK 999	UNP Q6TFC5
A	94	LEU	PHE	SEE REMARK 999	UNP Q6TFC5
A	95	VAL	LEU	SEE REMARK 999	UNP Q6TFC5
A	116	TYR	CYS	SEE REMARK 999	UNP Q6TFC5
A	137	LEU	-	expression tag	UNP Q6TFC5
A	138	GLU	-	expression tag	UNP Q6TFC5
A	139	HIS	-	expression tag	UNP Q6TFC5
A	140	HIS	-	expression tag	UNP Q6TFC5
A	141	HIS	-	expression tag	UNP Q6TFC5
A	142	HIS	-	expression tag	UNP Q6TFC5
A	143	HIS	-	expression tag	UNP Q6TFC5
A	144	HIS	-	expression tag	UNP Q6TFC5
B	51	ASN	HIS	engineered mutation	UNP Q6TFC5
B	52	SER	ALA	SEE REMARK 999	UNP Q6TFC5
B	94	LEU	PHE	SEE REMARK 999	UNP Q6TFC5
B	95	VAL	LEU	SEE REMARK 999	UNP Q6TFC5
B	116	TYR	CYS	SEE REMARK 999	UNP Q6TFC5
B	137	LEU	-	expression tag	UNP Q6TFC5
B	138	GLU	-	expression tag	UNP Q6TFC5
B	139	HIS	-	expression tag	UNP Q6TFC5
B	140	HIS	-	expression tag	UNP Q6TFC5
B	141	HIS	-	expression tag	UNP Q6TFC5
B	142	HIS	-	expression tag	UNP Q6TFC5
B	143	HIS	-	expression tag	UNP Q6TFC5

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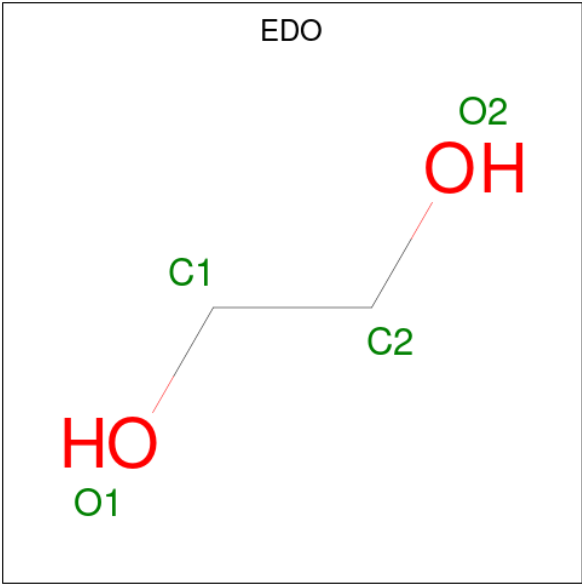
Chain	Residue	Modelled	Actual	Comment	Reference
B	144	HIS	-	expression tag	UNP Q6TFC5

- Molecule 2 is dTDP-4-keto-6-deoxyglucose (CCD ID: T46) (formula: C₁₆H₂₄N₂O₁₅P₂).



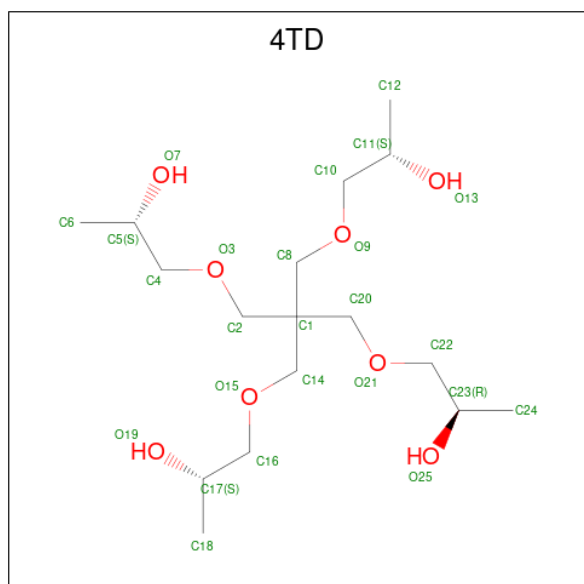
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			35	16	2	15	2		
2	B	1	Total	C	N	O	P	0	0
			35	16	2	15	2		

- Molecule 3 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: C₂H₆O₂).



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

- Molecule 4 is (2S)-1-[3-[(2S)-2-oxidanylpropoxy]-2-[[[(2S)-2-oxidanylpropoxy]methyl]-2-[[[(2R)-2-oxidanylpropoxy]methyl]propoxy]propan-2-ol (CCD ID: 4TD) (formula: C₁₇H₃₆O₈).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	B	1	Total	C	O	0	0
			25	17	8		

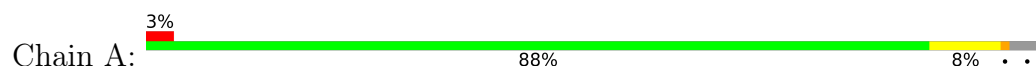
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	96	Total	O	0	0
			96	96		
5	B	77	Total	O	0	0
			77	77		

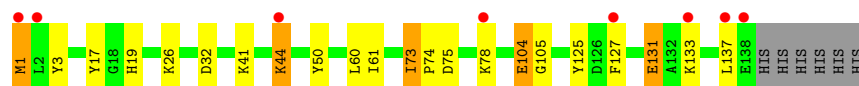
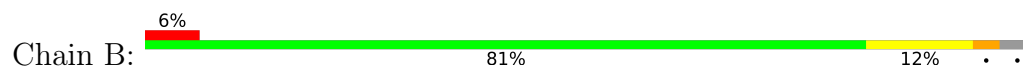
3 Residue-property plots [i](#)

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: QdtA



• Molecule 1: QdtA



4 Data and refinement statistics

Property	Value	Source
Space group	P 4 21 2	Depositor
Cell constants a, b, c, α , β , γ	95.40Å 95.40Å 94.64Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.97 – 1.90 29.97 – 1.90	Depositor EDS
% Data completeness (in resolution range)	95.8 (29.97-1.90) 95.7 (29.97-1.90)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	0.08	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.70 (at 1.91Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.201 , 0.241 0.207 , 0.243	Depositor DCC
R_{free} test set	1701 reflections (4.85%)	wwPDB-VP
Wilson B-factor (Å ²)	21.0	Xtriage
Anisotropy	0.233	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 36.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	0.029 for -h,-l,-k 0.022 for l,-k,h	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	2588	wwPDB-VP
Average B, all atoms (Å ²)	28.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.71% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 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: 4TD, T46, EDO

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	0/1188	0.76	0/1604
1	B	0.64	0/1188	0.82	2/1604 (0.1%)
All	All	0.64	0/2376	0.79	2/3208 (0.1%)

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	0	1
All	All	0	2

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
1	B	73	ILE	CA-C-N	-5.04	114.54	119.93
1	B	73	ILE	C-N-CA	-5.04	114.54	119.93

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	1	MET	Peptide
1	B	104	GLU	Peptide

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	1158	0	1175	6	0
1	B	1158	0	1175	14	0
2	A	35	0	22	0	0
2	B	35	0	22	0	0
3	B	4	0	6	1	0
4	B	25	0	36	2	0
5	A	96	0	0	3	0
5	B	77	0	0	1	0
All	All	2588	0	2436	19	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 4.

All (19) 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:B:105:GLY:HA2	5:B:364:HOH:O	2.00	0.62
1:B:127[A]:PHE:CE1	1:B:131:GLU:OE1	2.55	0.59
1:B:125:TYR:CE2	4:B:203:4TD:H15	2.42	0.55
1:A:60:LEU:C	1:A:61:ILE:HG13	2.38	0.48
5:A:356:HOH:O	1:B:41:LYS:HE2	2.13	0.48
1:B:1:MET:HE2	1:B:3:TYR:OH	2.15	0.47
1:B:60:LEU:C	1:B:61:ILE:HG13	2.39	0.47
1:A:32:ASP:OD2	5:A:359:HOH:O	2.21	0.46
1:B:50:TYR:CG	4:B:203:4TD:H31	2.52	0.45
1:B:133:LYS:HG2	1:B:137:LEU:HD12	1.98	0.45
1:B:74:PRO:O	1:B:75:ASP:HB2	2.16	0.45
1:A:20:LEU:HD23	1:A:20:LEU:C	2.42	0.45
1:B:44:LYS:H	1:B:44:LYS:CD	2.30	0.44
1:A:41:LYS:HE2	1:B:19:HIS:CD2	2.53	0.44
1:A:114:GLU:OE1	5:A:326:HOH:O	2.21	0.43
1:B:26:LYS:HE2	1:B:32:ASP:OD1	2.18	0.43
1:B:73:ILE:O	1:B:74:PRO:C	2.60	0.43
1:B:17:TYR:CG	3:B:202:EDO:H22	2.54	0.42
1:A:37:TYR:OH	1:A:58:GLN:NE2	2.52	0.42

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	137/144 (95%)	131 (96%)	6 (4%)	0	100	100
1	B	137/144 (95%)	129 (94%)	8 (6%)	0	100	100
All	All	274/288 (95%)	260 (95%)	14 (5%)	0	100	100

There are no Ramachandran outliers to report.

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	128/133 (96%)	124 (97%)	4 (3%)	35	29
1	B	128/133 (96%)	123 (96%)	5 (4%)	28	21
All	All	256/266 (96%)	247 (96%)	9 (4%)	32	24

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	MET
1	A	72	LYS
1	A	76	GLU
1	A	131	GLU
1	B	1	MET

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Mol	Chain	Res	Type
1	B	44	LYS
1	B	78	LYS
1	B	104	GLU
1	B	131	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	58	GLN
1	B	58	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](#)

Mogul failed to run properly - this section is therefore empty.

5.5 Carbohydrates [i](#)

Mogul failed to run properly - this section is therefore empty.

5.6 Ligand geometry [i](#)

Mogul failed to run properly - this section is therefore empty.

5.7 Other polymers [i](#)

Mogul failed to run properly - this section is therefore empty.

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	138/144 (95%)	-0.03	4 (2%)	53	57	14, 24, 47, 87	1 (0%)
1	B	138/144 (95%)	0.08	8 (5%)	29	30	14, 26, 54, 81	1 (0%)
All	All	276/288 (95%)	0.02	12 (4%)	40	42	14, 25, 51, 87	2 (0%)

All (12) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	1	MET	4.8
1	B	2	LEU	4.2
1	B	127[A]	PHE	3.4
1	A	138	GLU	3.2
1	B	137	LEU	3.1
1	A	1	MET	3.0
1	A	137	LEU	2.6
1	A	127[A]	PHE	2.5
1	B	78	LYS	2.5
1	B	133	LYS	2.4
1	B	44	LYS	2.3
1	B	138	GLU	2.2

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 oligosaccharides 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
4	4TD	B	203	25/25	0.79	0.35	44,57,64,68	25
3	EDO	B	202	4/4	0.92	0.10	32,36,38,44	0
2	T46	B	201	35/35	0.97	0.06	16,22,27,28	0
2	T46	A	201	35/35	0.98	0.04	16,19,26,26	0

6.5 Other polymers [i](#)

There are no such residues in this entry.