



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 17, 2026 – 06:45 PM UTC

PDB ID : 5I3F / pdb_00005i3f
Title : Structure-Function Studies on Role of Hydrophobic Clamping of a Basic Glutamate in Catalysis by Triosephosphate Isomerase
Authors : Drake, E.J.; Gulick, A.M.; Richard, J.P.; Zhai, X.; Kim, K.; Reinhardt, C.J.
Deposited on : 2016-02-10
Resolution : 1.72 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
Xtriage (Phenix)	:	2.0
EDS	:	3.0
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

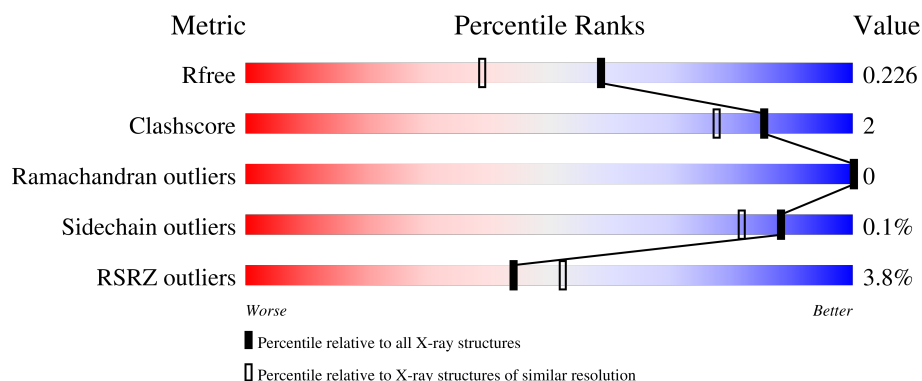
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.72 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	1039 (1.72-1.72)
Clashscore	190562	1049 (1.72-1.72)
Ramachandran outliers	187476	1041 (1.72-1.72)
Sidechain outliers	187428	1041 (1.72-1.72)
RSRZ outliers	180081	1039 (1.72-1.72)

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	250	5% 94% 6%
1	B	250	2% 94% 5%
1	C	250	6% 89% 7%
1	D	250	2% 99%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 8103 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 Triosephosphate isomerase, glycosomal.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	249	Total	C	N	O	S	0	0	0
			1854	1181	325	343	5			
1	B	249	Total	C	N	O	S	0	1	0
			1850	1177	323	344	6			
1	C	242	Total	C	N	O	S	0	1	0
			1825	1161	323	337	4			
1	D	249	Total	C	N	O	S	0	0	0
			1844	1171	322	346	5			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	172	ALA	ILE	engineered mutation	UNP P04789
B	172	ALA	ILE	engineered mutation	UNP P04789
C	172	ALA	ILE	engineered mutation	UNP P04789
D	172	ALA	ILE	engineered mutation	UNP P04789

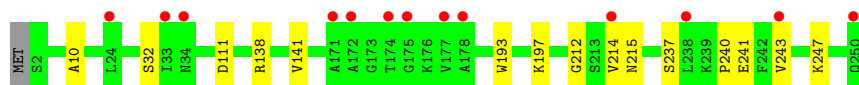
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	171	Total	O	0	0
			171	171		
2	B	191	Total	O	0	0
			191	191		
2	C	196	Total	O	0	0
			196	196		
2	D	172	Total	O	0	0
			172	172		

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.

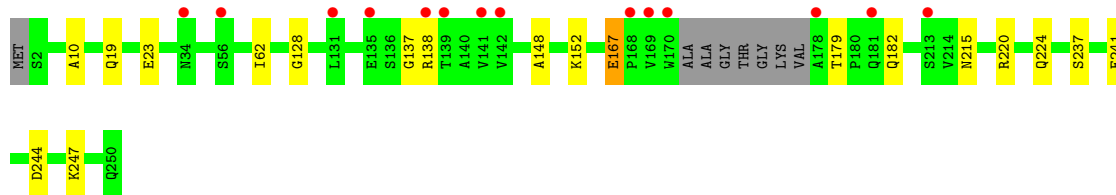
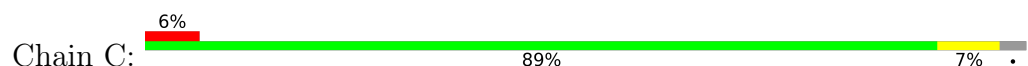
- Molecule 1: Triosephosphate isomerase, glycosomal



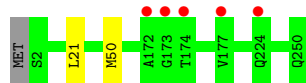
- Molecule 1: Triosephosphate isomerase, glycosomal



- Molecule 1: Triosephosphate isomerase, glycosomal



- Molecule 1: Triosephosphate isomerase, glycosomal



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	70.85Å 87.90Å 74.85Å 90.00° 106.01° 90.00°	Depositor
Resolution (Å)	34.05 – 1.72 34.05 – 1.72	Depositor EDS
% Data completeness (in resolution range)	98.2 (34.05-1.72) 94.7 (34.05-1.72)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.44 (at 1.72Å)	Xtriage
Refinement program	PHENIX (1.10.1_2155: ???)	Depositor
R, R_{free}	0.187 , 0.227 0.188 , 0.226	Depositor DCC
R_{free} test set	4625 reflections (4.93%)	wwPDB-VP
Wilson B-factor (Å ²)	19.9	Xtriage
Anisotropy	1.079	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 42.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	8103	wwPDB-VP
Average B, all atoms (Å ²)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.16% 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 [i](#)

5.1 Standard geometry [i](#)

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	0.23	0/1888	0.42	0/2565
1	B	0.27	0/1884	0.45	0/2561
1	C	0.30	1/1858 (0.1%)	0.44	0/2523
1	D	0.25	0/1878	0.44	0/2557
All	All	0.27	1/7508 (0.0%)	0.44	0/10206

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	167	GLU	C-N	-5.50	1.21	1.33

There are no bond angle outliers.

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	1854	0	1871	9	0
1	B	1850	0	1849	10	0
1	C	1825	0	1830	13	0
1	D	1844	0	1829	1	0
2	A	171	0	0	3	0
2	B	191	0	0	4	0
2	C	196	0	0	1	0
2	D	172	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	8103	0	7379	33	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 2.

All (33) 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:138[B]:ARG:HH21	1:C:138[B]:ARG:HA	1.49	0.77
1:A:111:ASP:OD2	2:A:301:HOH:O	2.13	0.66
1:B:155:LYS:NZ	2:B:302:HOH:O	2.27	0.60
1:A:141:VAL:HG23	2:A:325:HOH:O	2.02	0.58
1:C:244:ASP:HA	1:C:247:LYS:HE2	1.86	0.57
1:B:176:LYS:NZ	2:B:305:HOH:O	2.33	0.57
1:A:193:TRP:CE2	1:A:197:LYS:HG3	2.41	0.55
1:A:32:SER:O	1:A:247:LYS:NZ	2.40	0.54
1:D:21:LEU:HB2	1:D:50:MET:HE1	1.89	0.54
1:C:137:GLY:O	1:C:138[B]:ARG:HD2	2.08	0.53
1:C:19:GLN:NE2	1:C:23:GLU:OE2	2.39	0.52
1:C:220:ARG:O	1:C:224:GLN:HG3	2.09	0.52
1:C:148:ALA:O	1:C:152:LYS:HG2	2.11	0.50
1:A:138:ARG:HA	2:A:325:HOH:O	2.12	0.49
1:A:215:ASN:HB2	1:A:241:GLU:OE2	2.12	0.49
1:A:240:PRO:O	1:A:243:VAL:HG22	2.12	0.49
1:B:217:LYS:NZ	2:B:303:HOH:O	2.29	0.49
1:C:138[B]:ARG:HA	1:C:138[B]:ARG:NH2	2.24	0.49
1:B:84:LYS:HG2	1:B:121:PHE:CE1	2.48	0.48
1:A:212:GLY:O	1:A:214:VAL:HG23	2.14	0.47
1:B:25:ILE:HD12	1:B:50[B]:MET:SD	2.54	0.47
1:B:241:GLU:OE2	2:B:301:HOH:O	2.21	0.45
1:C:138[B]:ARG:HA	1:C:138[B]:ARG:HD2	1.63	0.45
1:C:215:ASN:HB2	1:C:241:GLU:OE1	2.17	0.45
1:B:10:ALA:HB1	1:B:237:SER:HB2	2.00	0.44
1:B:155:LYS:HG2	1:B:158:ASP:OD2	2.19	0.43
1:C:10:ALA:HB1	1:C:237:SER:HB2	1.99	0.43
1:B:25:ILE:HG23	1:B:55:LEU:HD13	2.01	0.42
1:C:62:ILE:HG23	2:C:364:HOH:O	2.19	0.42
1:C:128:GLY:HA3	1:C:167:GLU:O	2.19	0.42
1:C:179:THR:HG1	1:C:182:GLN:HG3	1.85	0.41
1:B:79:SER:HB2	1:B:81:PRO:HD2	2.02	0.41
1:A:10:ALA:HB1	1:A:237:SER:HB2	2.02	0.41

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	247/250 (99%)	240 (97%)	7 (3%)	0	100	100
1	B	248/250 (99%)	243 (98%)	5 (2%)	0	100	100
1	C	239/250 (96%)	234 (98%)	5 (2%)	0	100	100
1	D	247/250 (99%)	244 (99%)	3 (1%)	0	100	100
All	All	981/1000 (98%)	961 (98%)	20 (2%)	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	189/196 (96%)	189 (100%)	0	100	100
1	B	187/196 (95%)	186 (100%)	1 (0%)	81	71
1	C	186/196 (95%)	186 (100%)	0	100	100
1	D	186/196 (95%)	186 (100%)	0	100	100
All	All	748/784 (95%)	747 (100%)	1 (0%)	88	82

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	55	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (9) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	18	GLN
1	A	38	GLN
1	A	250	GLN
1	B	38	GLN
1	B	224	GLN
1	B	225	GLN
1	B	250	GLN
1	C	181	GLN
1	D	18	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

There are no ligands in this entry.

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 ⓘ

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	249/250 (99%)	0.50	13 (5%) 33 38	18, 26, 40, 55	0
1	B	249/250 (99%)	0.45	6 (2%) 59 67	13, 25, 34, 41	1 (0%)
1	C	242/250 (96%)	0.47	14 (5%) 29 35	16, 24, 37, 48	1 (0%)
1	D	249/250 (99%)	0.35	5 (2%) 65 72	17, 25, 36, 48	0
All	All	989/1000 (98%)	0.44	38 (3%) 44 52	13, 25, 37, 55	2 (0%)

All (38) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	170	TRP	6.4
1	C	168	PRO	4.2
1	C	169	VAL	3.7
1	A	177	VAL	3.6
1	D	173	GLY	3.5
1	C	141	VAL	3.5
1	A	171	ALA	3.5
1	C	178	ALA	3.3
1	D	177	VAL	3.2
1	B	176	LYS	3.1
1	A	214	VAL	3.1
1	B	214	VAL	3.1
1	C	142	VAL	3.0
1	D	224	GLN	3.0
1	A	172	ALA	2.9
1	C	181	GLN	2.7
1	C	138[A]	ARG	2.7
1	C	139	THR	2.7
1	A	243	VAL	2.6
1	C	56	SER	2.5
1	A	34	ASN	2.5

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Mol	Chain	Res	Type	RSRZ
1	B	137	GLY	2.5
1	A	178	ALA	2.4
1	A	174	THR	2.4
1	C	34	ASN	2.3
1	A	24	LEU	2.3
1	A	175	GLY	2.3
1	C	213	SER	2.3
1	A	33	ILE	2.3
1	B	175	GLY	2.2
1	D	174	THR	2.2
1	D	172	ALA	2.2
1	C	131	LEU	2.2
1	A	250	GLN	2.1
1	B	131	LEU	2.1
1	A	238	LEU	2.0
1	C	135	GLU	2.0
1	B	142	VAL	2.0

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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.