



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 04:33 PM UTC

PDB ID : 4HOW / pdb_00004how
Title : The crystal structure of isomaltulose synthase from *Erwinia rhapontici* NX5
Authors : Xu, Z.; Li, S.; Xu, H.; Zhou, J.
Deposited on : 2012-10-22
Resolution : 1.70 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) : 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

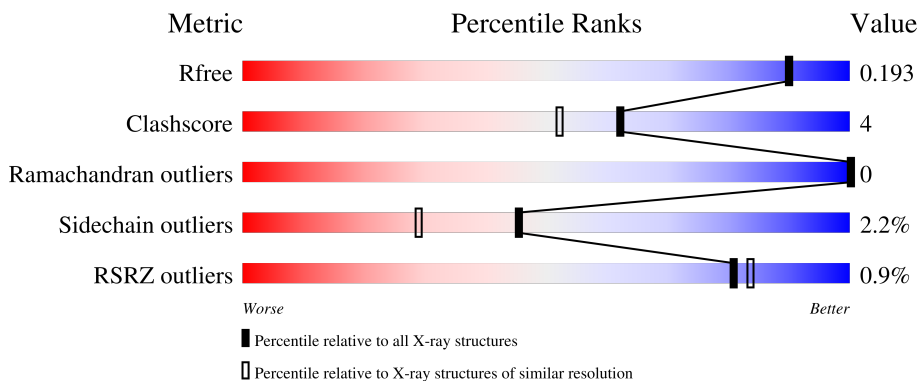
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.70 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	5551 (1.70-1.70)
Clashscore	190562	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)
RSRZ outliers	180081	5554 (1.70-1.70)

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	600	

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 5486 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 Sucrose isomerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	559	4739	3017	823	890	9	0	12	0

- Molecule 2 is GLYCEROL (CCD ID: GOL) (formula: C₃H₈O₃).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	6	3	3	0	0
2	A	1	6	3	3	0	0
2	A	1	6	3	3	0	0

- Molecule 3 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Ca	0	0
			1	1		

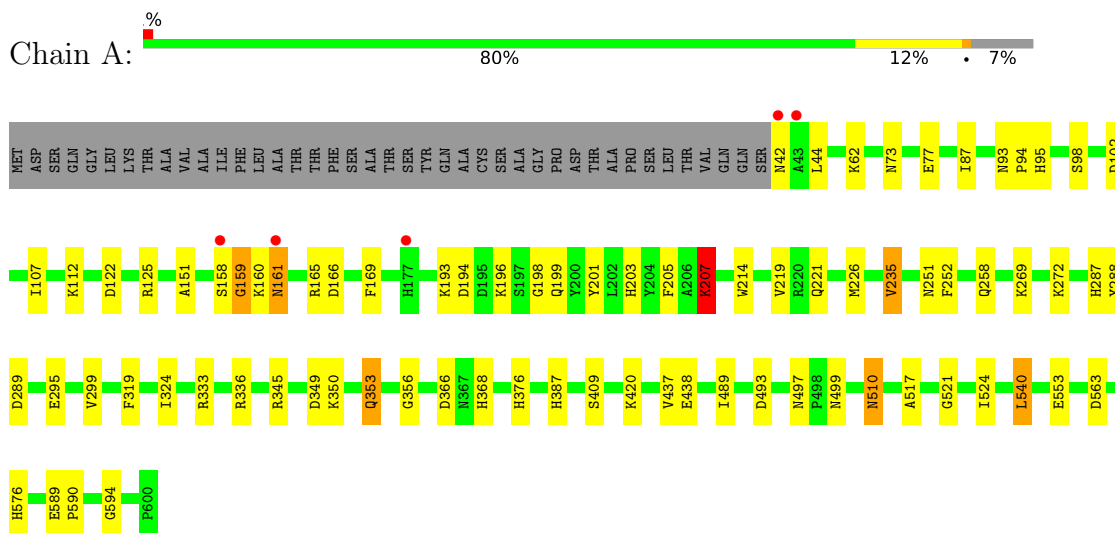
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	728	Total	O	0	0
			728	728		

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: Sucrose isomerase



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	58.86Å 81.27Å 138.00Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	45.06 – 1.70 45.06 – 1.70	Depositor EDS
% Data completeness (in resolution range)	98.9 (45.06-1.70) 99.0 (45.06-1.70)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.75 (at 1.70Å)	Xtrriage
Refinement program	REFMAC 5.6.0117	Depositor
R, R_{free}	0.159 , 0.193 0.158 , 0.193	Depositor DCC
R_{free} test set	3715 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å ²)	20.3	Xtrriage
Anisotropy	0.022	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 35.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	5486	wwPDB-VP
Average B, all atoms (Å ²)	21.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.04% 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

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

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	1.59	29/4893 (0.6%)	1.35	14/6631 (0.2%)

All (29) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	387	HIS	ND1-CE1	8.48	1.41	1.32
1	A	87	ILE	N-CA	6.84	1.54	1.46
1	A	376	HIS	ND1-CE1	6.80	1.39	1.32
1	A	203	HIS	CE1-NE2	6.54	1.39	1.32
1	A	576	HIS	CG-CD2	6.30	1.42	1.35
1	A	87	ILE	CA-CB	6.26	1.61	1.54
1	A	158	SER	CA-C	6.12	1.61	1.52
1	A	287	HIS	N-CA	5.73	1.53	1.46
1	A	95	HIS	CE1-NE2	5.65	1.38	1.32
1	A	333	ARG	N-CA	5.51	1.53	1.46
1	A	102	ASP	N-CA	5.38	1.53	1.46
1	A	203	HIS	CG-CD2	5.37	1.41	1.35
1	A	219	VAL	C-O	5.34	1.30	1.24
1	A	289	ASP	CA-CB	5.30	1.59	1.52
1	A	235	VAL	CA-CB	5.28	1.59	1.54
1	A	438	GLU	N-CA	5.23	1.53	1.46
1	A	489	ILE	C-O	5.21	1.30	1.24
1	A	510[A]	ASN	C-O	5.20	1.30	1.24
1	A	510[B]	ASN	C-O	5.20	1.30	1.24
1	A	594	GLY	N-CA	5.17	1.51	1.45
1	A	98	SER	CA-C	5.16	1.57	1.52
1	A	159	GLY	N-CA	5.16	1.52	1.45
1	A	207	LYS	N-CA	5.13	1.52	1.46
1	A	288	TYR	C-O	5.10	1.30	1.23
1	A	151	ALA	N-CA	5.09	1.52	1.46
1	A	368	HIS	CB-CG	5.04	1.57	1.50

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	345	ARG	CD-NE	5.03	1.53	1.46
1	A	226	MET	CA-C	5.01	1.59	1.52
1	A	214	TRP	CD2-CE2	5.00	1.49	1.41

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	252	PHE	CA-C-N	-7.95	112.58	120.21
1	A	252	PHE	C-N-CA	-7.95	112.58	120.21
1	A	219	VAL	N-CA-C	-7.56	103.42	110.53
1	A	221	GLN	N-CA-C	6.21	118.05	111.28
1	A	251	ASN	CA-C-N	-5.77	117.56	123.10
1	A	251	ASN	C-N-CA	-5.77	117.56	123.10
1	A	437	VAL	N-CA-C	-5.67	106.29	111.67
1	A	166	ASP	N-CA-C	-5.41	107.23	112.97
1	A	409[A]	SER	N-CA-C	-5.29	105.68	111.82
1	A	409[B]	SER	N-CA-C	-5.29	105.68	111.82
1	A	205	PHE	CA-C-O	-5.27	114.89	117.94
1	A	299	VAL	CA-C-O	5.19	122.99	119.20
1	A	269	LYS	N-CA-C	-5.14	106.60	112.92
1	A	107	ILE	O-C-N	5.11	128.70	123.03

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	4739	0	4525	38	0
2	A	18	0	24	1	0
3	A	1	0	0	0	0
4	A	728	0	0	16	1
All	All	5486	0	4549	38	1

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 (38) 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:350[B]:LYS:HE2	4:A:1187:HOH:O	1.61	0.99
1:A:510[B]:ASN:OD1	4:A:1239:HOH:O	1.88	0.91
1:A:493:ASP:HB2	4:A:1241:HOH:O	1.69	0.90
1:A:350[B]:LYS:HD2	4:A:1377:HOH:O	1.71	0.89
1:A:62[B]:LYS:HE2	4:A:1497:HOH:O	1.78	0.83
1:A:193:LYS:HE3	4:A:1519:HOH:O	1.79	0.80
1:A:77[B]:GLU:HG3	4:A:1367:HOH:O	1.82	0.80
1:A:125[A]:ARG:NH1	4:A:1507:HOH:O	2.23	0.71
1:A:353:GLN:HG3	4:A:1513:HOH:O	1.97	0.63
1:A:517:ALA:HA	1:A:540:LEU:HD22	1.81	0.62
1:A:350[B]:LYS:CE	4:A:1187:HOH:O	2.34	0.61
1:A:159:GLY:C	1:A:161:ASN:H	2.08	0.60
1:A:160:LYS:HE3	4:A:1308:HOH:O	2.02	0.59
1:A:62[A]:LYS:NZ	1:A:77[A]:GLU:OE2	2.33	0.56
1:A:73:ASN:OD1	1:A:125[B]:ARG:NH2	2.40	0.54
1:A:272:LYS:CE	4:A:1505:HOH:O	2.55	0.54
1:A:159:GLY:C	1:A:161:ASN:N	2.65	0.52
1:A:193:LYS:HG3	1:A:194:ASP:N	2.25	0.51
1:A:497:ASN:ND2	1:A:499:ASN:H	2.08	0.51
1:A:324:ILE:HD11	1:A:366:ASP:HA	1.92	0.50
1:A:553:GLU:HA	1:A:590:PRO:HB3	1.94	0.50
1:A:165:ARG:NH2	1:A:199:GLN:OE1	2.41	0.50
1:A:349:ASP:HB2	4:A:1326:HOH:O	2.12	0.48
1:A:122:ASP:OD1	1:A:125[B]:ARG:NH2	2.39	0.47
1:A:193:LYS:HE2	1:A:198:GLY:HA2	1.98	0.46
1:A:350[B]:LYS:HG3	4:A:843:HOH:O	2.15	0.46
1:A:112:LYS:HE2	1:A:112:LYS:HB2	1.66	0.46
1:A:207:LYS:HB3	1:A:207:LYS:HE3	1.47	0.45
1:A:521:GLY:HA2	1:A:540:LEU:HD13	1.99	0.44
1:A:169:PHE:O	1:A:201:TYR:HA	2.18	0.43
1:A:497:ASN:ND2	1:A:497:ASN:C	2.77	0.43
1:A:161:ASN:ND2	4:A:1442:HOH:O	2.51	0.42
1:A:356:GLY:HA2	4:A:1528:HOH:O	2.20	0.42
1:A:589:GLU:HB3	1:A:590:PRO:HD2	2.02	0.41
1:A:524:ILE:HD12	2:A:703:GOL:H2	2.03	0.41
1:A:258:GLN:NE2	1:A:258:GLN:HA	2.35	0.41
1:A:93:ASN:HB3	1:A:94:PRO:CD	2.51	0.40
1:A:295:GLU:HA	1:A:319:PHE:HB2	2.02	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the sym-

metry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:A:1360:HOH:O	4:A:1480:HOH:O[1_455]	2.00	0.20

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	569/600 (95%)	550 (97%)	19 (3%)	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	512/532 (96%)	501 (98%)	11 (2%)	47 30

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	42	ASN
1	A	44	LEU
1	A	161	ASN
1	A	196	LYS
1	A	207	LYS
1	A	235	VAL

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Mol	Chain	Res	Type
1	A	336	ARG
1	A	353	GLN
1	A	420	LYS
1	A	540	LEU
1	A	563	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (11) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	50	GLN
1	A	161	ASN
1	A	258	GLN
1	A	453	GLN
1	A	496	ASN
1	A	497	ASN
1	A	499	ASN
1	A	567	ASN
1	A	576	HIS
1	A	585	GLN
1	A	599	ASN

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](#)

Of 4 ligands modelled in this entry, 1 is monoatomic - leaving 3 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	GOL	A	701	-	5,5,5	0.56	0	5,5,5	0.96	0
2	GOL	A	702	-	5,5,5	1.16	0	5,5,5	0.66	0
2	GOL	A	703	-	5,5,5	0.53	0	5,5,5	0.71	0

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	GOL	A	701	-	-	0/4/4/4	-
2	GOL	A	702	-	-	0/4/4/4	-
2	GOL	A	703	-	-	4/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	703	GOL	C1-C2-C3-O3
2	A	703	GOL	O2-C2-C3-O3
2	A	703	GOL	O1-C1-C2-C3
2	A	703	GOL	O1-C1-C2-O2

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	703	GOL	1	0

5.7 Other polymers [i](#)

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 [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	559/600 (93%)	-0.49	5 (0%) 81 83	5, 18, 34, 58	12 (2%)

All (5) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	158	SER	2.7
1	A	42	ASN	2.7
1	A	161	ASN	2.4
1	A	177	HIS	2.2
1	A	43	ALA	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](#)

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
2	GOL	A	703	6/6	0.89	0.15	22,40,67,70	0
2	GOL	A	702	6/6	0.96	0.07	16,19,23,23	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(\AA^2)	Q<0.9
2	GOL	A	701	6/6	0.98	0.04	15,19,21,22	0
3	CA	A	704	1/1	0.98	0.14	31,31,31,31	0

6.5 Other polymers [i](#)

There are no such residues in this entry.