Full wwPDB X-ray Structure Validation Report ⓘ

Oct 27, 2026 – 02:46 AM JST

PDB ID	:	9XHL / pdb_00009xhl
Title	:	Enzyme directed charge redistribution of substrate underlies regioselectivity in CO2 fixation by salicylic acid decarboxylase
Authors	:	Song, X.
Deposited on	:	2025-11-01
Resolution	:	2.12 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:

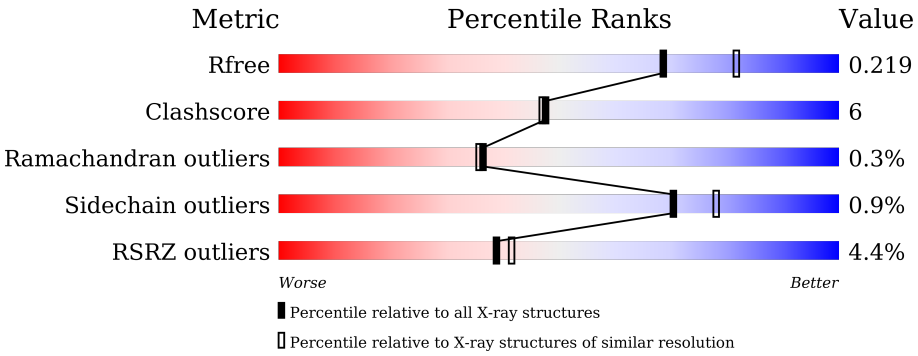
MolProbity	:	4-5-2 with Phenix2.2
Xtriage (Phenix)	:	2.2
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.015 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.51

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 2.12 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	8290 (2.14-2.10)
Clashscore	190562	8817 (2.14-2.10)
Ramachandran outliers	187476	8738 (2.14-2.10)
Sidechain outliers	187428	8739 (2.14-2.10)
RSRZ outliers	180081	8294 (2.14-2.10)

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 <=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	350	4% 89% 11%
1	B	350	5% 84% 16%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 6217 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 Salicylate decarboxylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	350	Total	C	N	O	S	0	0	0
			2808	1795	479	521	13			
1	B	350	Total	C	N	O	S	0	0	0
			2808	1795	479	521	13			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	23	ALA	LYS	conflict	UNP P0CT50
A	27	ALA	TYR	conflict	UNP P0CT50
A	64	THR	TYR	conflict	UNP P0CT50
A	291	ASP	GLU	conflict	UNP P0CT50
B	23	ALA	LYS	conflict	UNP P0CT50
B	27	ALA	TYR	conflict	UNP P0CT50
B	64	THR	TYR	conflict	UNP P0CT50
B	291	ASP	GLU	conflict	UNP P0CT50

- Molecule 2 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Mg	0	0
			1	1		
2	B	1	Total	Mg	0	0
			1	1		

- Molecule 3 is water.

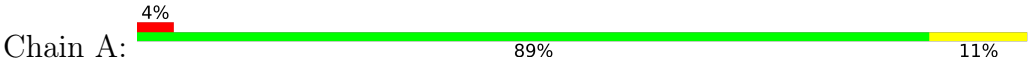
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	344	Total	O	0	0
			344	344		
3	B	255	Total	O	0	0
			255	255		

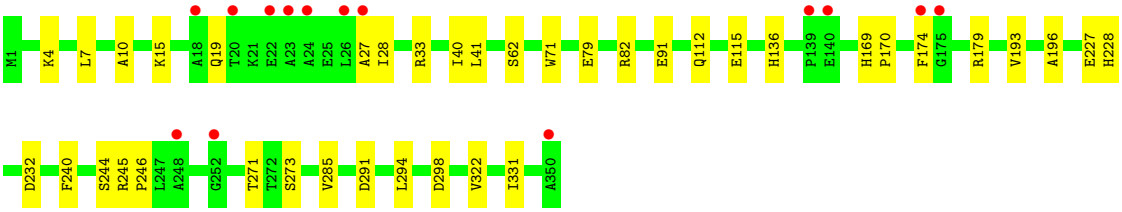
3 Residue-property plots (i)

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: Salicylate decarboxylase

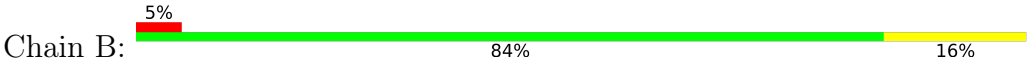
Chain A:

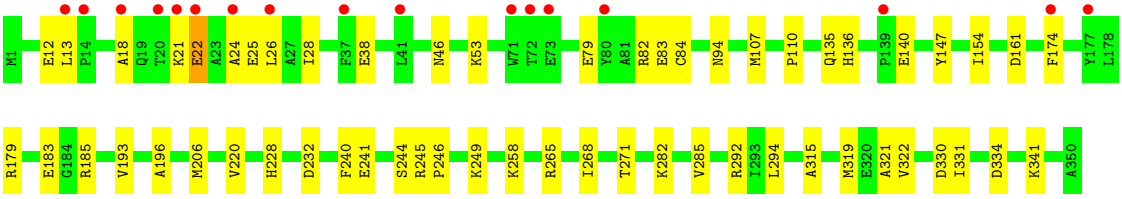




• Molecule 1: Salicylate decarboxylase

Chain B:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	59.07Å 92.71Å 127.36Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	49.82 – 2.12 49.82 – 2.12	Depositor EDS
% Data completeness (in resolution range)	86.5 (49.82-2.12) 88.9 (49.82-2.12)	Depositor EDS
R_{merge}	0.28	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	4.61 (at 2.05Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487, PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.167 , 0.214 0.173 , 0.219	Depositor DCC
R_{free} test set	1957 reflections (4.39%)	wwPDB-VP
Wilson B-factor (Å^2)	24.7	Xtriage
Anisotropy	0.066	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 48.7	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	6217	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 6.97% 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, 0.333 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: MG

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	0.36	0/2890	0.55	0/3913
1	B	0.32	0/2890	0.52	0/3913
All	All	0.34	0/5780	0.54	0/7826

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	B	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	185	ARG	Sidechain

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	2808	0	2678	25	0
1	B	2808	0	2678	36	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	344	0	0	3	2
3	B	255	0	0	7	1
All	All	6217	0	5356	61	2

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 6.

All (61) 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:13:LEU:HD21	1:B:84:CYS:HA	1.56	0.88
1:A:285:VAL:HG21	1:A:322:VAL:HG23	1.57	0.87
1:B:161:ASP:OD2	3:B:501:HOH:O	1.97	0.82
1:B:110:PRO:HB2	1:B:154:ILE:HD11	1.66	0.77
1:B:18:ALA:HA	1:B:21:LYS:HE3	1.69	0.73
1:B:21:LYS:NZ	3:B:503:HOH:O	2.18	0.73
1:B:285:VAL:HG21	1:B:322:VAL:HG13	1.73	0.70
1:A:291:ASP:OD2	3:A:501:HOH:O	2.12	0.67
1:B:179:ARG:HA	1:B:183:GLU:HG3	1.77	0.65
1:A:79:GLU:OE1	1:A:82:ARG:NH1	2.30	0.63
1:A:112:GLN:HA	1:A:115:GLU:OE1	1.99	0.63
1:B:140:GLU:O	3:B:502:HOH:O	2.16	0.62
1:B:315:ALA:O	1:B:319:MET:HG3	1.99	0.61
1:A:322:VAL:HG21	1:A:331:ILE:CD1	2.31	0.60
1:A:19:GLN:HE22	1:A:71:TRP:HE1	1.50	0.59
1:B:240:PHE:HA	1:B:244:SER:HB2	1.85	0.58
1:A:322:VAL:HG21	1:A:331:ILE:HD12	1.85	0.57
1:A:273:SER:HB2	1:A:298:ASP:HB2	1.90	0.54
1:B:341:LYS:NZ	3:B:508:HOH:O	2.27	0.54
1:B:53:LYS:HE3	3:B:728:HOH:O	2.09	0.52
1:B:271:THR:HA	1:B:294:LEU:O	2.08	0.52
1:A:33:ARG:HH11	1:A:33:ARG:HG3	1.74	0.52
1:B:12:GLU:OE2	3:B:504:HOH:O	2.19	0.51
1:A:240:PHE:HA	1:A:244:SER:HB2	1.92	0.51
1:A:15:LYS:NZ	3:A:513:HOH:O	2.44	0.51
1:B:322:VAL:HG11	1:B:331:ILE:HD12	1.92	0.51
1:B:330:ASP:HA	1:B:334:ASP:HB2	1.93	0.50
1:A:271:THR:HA	1:A:294:LEU:O	2.14	0.48

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:241:GLU:OE2	3:B:505:HOH:O	2.19	0.47
1:A:19:GLN:HE22	1:A:71:TRP:NE1	2.13	0.47
1:A:27:ALA:O	1:A:28:ILE:HD13	2.14	0.47
1:A:10:ALA:HA	1:A:62:SER:O	2.14	0.47
1:B:79:GLU:OE2	1:B:82:ARG:NH1	2.47	0.47
1:A:322:VAL:HG22	1:A:322:VAL:O	2.16	0.46
1:A:179:ARG:HH11	1:A:179:ARG:HG3	1.81	0.46
1:B:206:MET:HE1	1:B:220:VAL:HG21	1.96	0.46
1:A:227:GLU:O	1:A:228:HIS:HB2	2.16	0.45
1:B:38:GLU:OE1	1:B:46:ASN:HB2	2.16	0.45
1:B:107:MET:HB2	1:B:135:GLN:HB2	1.99	0.45
1:A:196:ALA:HB3	1:A:228:HIS:CE1	2.51	0.45
1:B:245:ARG:HB3	1:B:246:PRO:HD3	1.99	0.44
1:A:169:HIS:CG	1:A:170:PRO:HD2	2.52	0.44
1:A:40:ILE:HG23	1:A:41:LEU:HG	2.00	0.44
1:B:22:GLU:H	1:B:22:GLU:HG3	1.57	0.43
1:B:282:LYS:HB2	1:B:321:ALA:HB1	2.01	0.42
1:B:322:VAL:HG11	1:B:331:ILE:CD1	2.49	0.42
1:A:136:HIS:CE1	1:A:174:PHE:HB2	2.55	0.42
1:B:136:HIS:CE1	1:B:174:PHE:HB2	2.55	0.42
1:B:322:VAL:HG12	1:B:322:VAL:O	2.19	0.42
1:B:79:GLU:HG3	1:B:83:GLU:OE2	2.19	0.42
1:A:91:GLU:OE2	3:A:502:HOH:O	2.22	0.42
1:B:249:LYS:HD3	1:B:249:LYS:HA	1.82	0.42
1:B:220:VAL:O	1:B:268:ILE:HA	2.20	0.41
1:A:245:ARG:HB3	1:A:246:PRO:HD3	2.03	0.41
1:B:25:GLU:HG3	1:B:26:LEU:N	2.35	0.41
1:B:24:ALA:HA	1:B:28:ILE:HG12	2.01	0.41
1:B:107:MET:HG3	1:B:147:TYR:CZ	2.55	0.41
1:B:94:ASN:HD22	1:B:94:ASN:HA	1.74	0.41
1:B:265:ARG:HA	1:B:292:ARG:HD3	2.02	0.41
1:A:4:LYS:HB2	1:A:4:LYS:HE2	1.91	0.41
1:B:196:ALA:HB3	1:B:228:HIS:CE1	2.55	0.41

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:A:813:HOH:O	3:A:824:HOH:O[4_555]	2.14	0.06
3:A:724:HOH:O	3:B:733:HOH:O[2_354]	2.16	0.04

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	348/350 (99%)	329 (94%)	18 (5%)	1 (0%)	36	36
1	B	348/350 (99%)	332 (95%)	15 (4%)	1 (0%)	36	36
All	All	696/700 (99%)	661 (95%)	33 (5%)	2 (0%)	36	36

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	193	VAL
1	B	193	VAL

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	294/294 (100%)	292 (99%)	2 (1%)	76	83
1	B	294/294 (100%)	291 (99%)	3 (1%)	68	76
All	All	588/588 (100%)	583 (99%)	5 (1%)	70	78

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	7	LEU
1	A	232	ASP
1	B	22	GLU
1	B	232	ASP

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	B	258	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	19	GLN
1	A	144	HIS
1	A	262	HIS
1	B	94	ASN
1	B	157	GLN
1	B	181	GLN
1	B	267	ASN

5.3.3 RNA

There are no RNA molecules 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 oligosaccharides in this entry.

5.6 Ligand geometry

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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, 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	350/350 (100%)	0.12	14 (4%)	42	45	14, 21, 37, 52	0
1	B	350/350 (100%)	0.45	17 (4%)	35	37	14, 27, 46, 63	0
All	All	700/700 (100%)	0.29	31 (4%)	39	41	14, 24, 43, 63	0

All (31) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	24	ALA	5.5
1	B	20	THR	4.7
1	B	26	LEU	3.8
1	A	27	ALA	3.7
1	A	252	GLY	3.7
1	A	24	ALA	3.6
1	B	13	LEU	3.4
1	A	174	PHE	3.4
1	A	22	GLU	3.2
1	B	139	PRO	3.1
1	A	26	LEU	3.0
1	A	140	GLU	2.9
1	A	23	ALA	2.9
1	B	18	ALA	2.7
1	B	73	GLU	2.6
1	B	41	LEU	2.6
1	A	18	ALA	2.6
1	B	37	PHE	2.6
1	B	174	PHE	2.6
1	B	22	GLU	2.6
1	B	21	LYS	2.5
1	A	175	GLY	2.5
1	A	139	PRO	2.5
1	B	72	THR	2.4

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	B	14	PRO	2.4
1	B	71	TRP	2.3
1	B	80	TYR	2.3
1	A	248	ALA	2.3
1	A	350	ALA	2.1
1	B	177	TYR	2.1
1	A	20	THR	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, 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	B-factors(Å^2)	Q<0.9
2	MG	B	401	1/1	0.90	0.09	31,31,31,31	0
2	MG	A	401	1/1	0.94	0.07	23,23,23,23	0

6.5 Other polymers (i)

There are no such residues in this entry.