Full wwPDB X-ray Structure Validation Report (i)

Feb 6, 2024 – 10:37 PM EST

PDB ID	:	2AEX
Title	:	The 1.58A Crystal Structure of Human Coproporphyrinogen Oxidase Reveals the Structural Basis of Hereditary Coproporphyria
Authors	:	Lee, D.S.; Flachsova, E.; Bodnarova, M.; Demeler, B.; Martasek, P.; Raman, C.S.
Deposited on	:	2005-07-24
Resolution	:	1.58 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 (i) 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 (i)) were used in the production of this report:

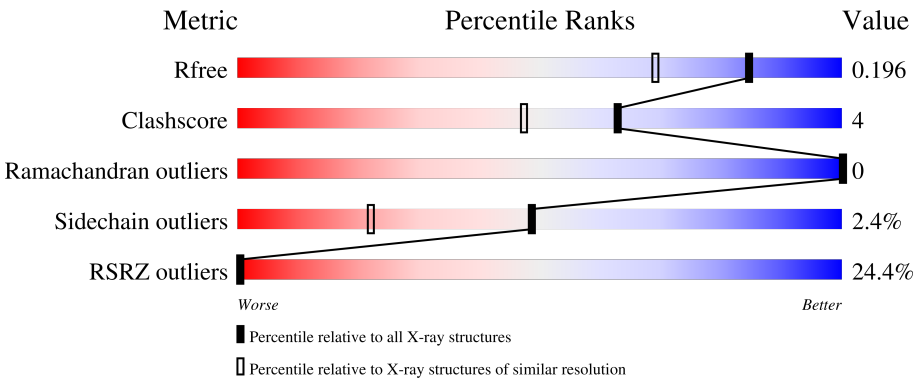
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

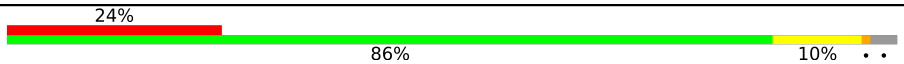
The reported resolution of this entry is 1.58 Å.

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}	130704	5534 (1.60-1.56)
Clashscore	141614	5861 (1.60-1.56)
Ramachandran outliers	138981	5708 (1.60-1.56)
Sidechain outliers	138945	5703 (1.60-1.56)
RSRZ outliers	127900	5431 (1.60-1.56)

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	346	

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 3198 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.

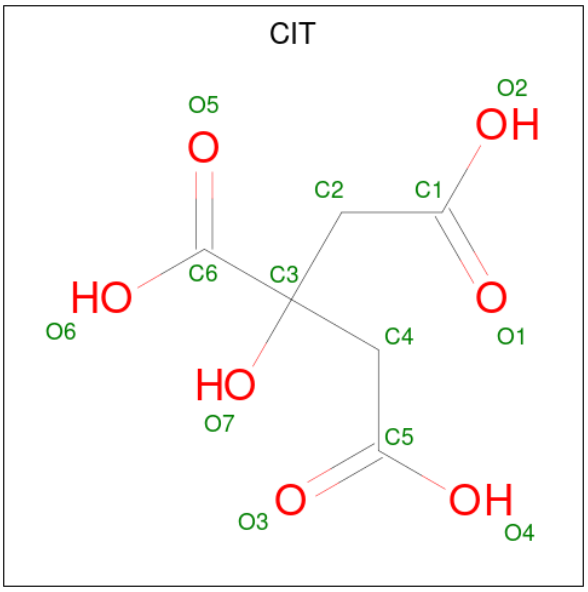
- Molecule 1 is a protein called Coproporphyrinogen III oxidase, mitochondrial.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	336	2822	1776	505	524	17	0	15	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	109	GLY	-	cloning artifact	UNP P36551
A	110	SER	-	cloning artifact	UNP P36551

- Molecule 2 is CITRIC ACID (three-letter code: CIT) (formula: $C_6H_8O_7$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	13	6	7	0	0

- Molecule 3 is water.

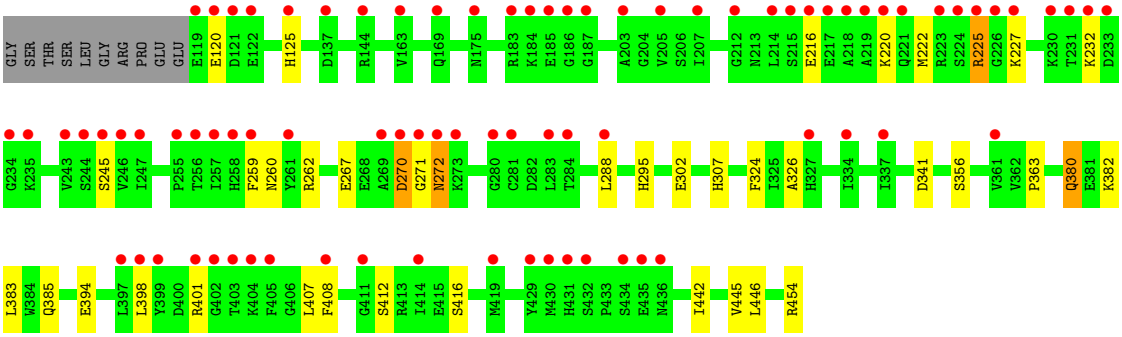
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	A	363	363	363	0	0

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: Coproporphyrinogen III oxidase, mitochondrial

Chain A:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 2 3	Depositor
Cell constants a, b, c, α, β, γ	112.74Å 112.74Å 112.74Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	31.31 – 1.58 31.27 – 1.58	Depositor EDS
% Data completeness (in resolution range)	99.5 (31.31-1.58) 99.5 (31.27-1.58)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.59 (at 1.58Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.186 , 0.208 0.197 , 0.196	Depositor DCC
R_{free} test set	3270 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å^2)	26.2	Xtriage
Anisotropy	0.000	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.37 , 49.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.52$, $< L^2 > = 0.36$	Xtriage
Estimated twinning fraction	0.019 for l,-k,h	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	3198	wwPDB-VP
Average B, all atoms (Å^2)	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.17% 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 (i)

5.1 Standard geometry (i)

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

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	0.55	0/2893	0.68	1/3902 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	454	ARG	NE-CZ-NH2	-5.63	117.49	120.30

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	2822	0	2717	24	0
2	A	13	0	5	0	0
3	A	363	0	0	3	0
All	All	3198	0	2722	24	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 (24) 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:341[A]:ASP:OD2	3:A:730:HOH:O	1.86	0.94
1:A:216:GLU:O	1:A:220:LYS:HG2	1.88	0.74
1:A:270[A]:ASP:OD1	1:A:272:ASN:HB2	1.89	0.72
1:A:225:ARG:HD2	1:A:227:LYS:HE2	1.72	0.69
1:A:412:SER:HB3	1:A:416[A]:SER:OG	1.96	0.65
1:A:382:LYS:NZ	1:A:385:GLN:HE22	1.98	0.61
1:A:270[A]:ASP:OD2	1:A:271:GLY:N	2.35	0.59
1:A:324:PHE:CE2	1:A:326:ALA:HA	2.41	0.56
1:A:307:HIS:HE1	1:A:356:SER:OG	1.88	0.56
1:A:227:LYS:N	1:A:227:LYS:HD2	2.21	0.55
1:A:307:HIS:HD2	3:A:513:HOH:O	1.90	0.53
1:A:295:HIS:HE1	1:A:363:PRO:O	1.94	0.51
1:A:302:GLU:HG3	3:A:704:HOH:O	2.11	0.50
1:A:222:MET:HE2	1:A:408:PHE:CE2	2.49	0.47
1:A:120:GLU:OE1	1:A:125:HIS:ND1	2.37	0.47
1:A:270[A]:ASP:CG	1:A:271:GLY:N	2.67	0.47
1:A:380:GLN:H	1:A:380:GLN:HE21	1.63	0.46
1:A:394:GLU:HG2	1:A:398[B]:LEU:HD23	1.98	0.45
1:A:245:SER:HB3	1:A:259:PHE:CE2	2.52	0.45
1:A:288:LEU:HD22	1:A:445[B]:VAL:HG21	2.01	0.43
1:A:380:GLN:H	1:A:380:GLN:NE2	2.17	0.42
1:A:260:ASN:ND2	1:A:262[A]:ARG:NH2	2.68	0.42
1:A:442:ILE:O	1:A:446:LEU:HG	2.21	0.41
1:A:232:LYS:NZ	1:A:267:GLU:OE1	2.39	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	349/346 (101%)	341 (98%)	8 (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	305/298 (102%)	296 (97%)	9 (3%)	41 15

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

Mol	Chain	Res	Type
1	A	225	ARG
1	A	270[A]	ASP
1	A	270[B]	ASP
1	A	272	ASN
1	A	380	GLN
1	A	383[A]	LEU
1	A	383[B]	LEU
1	A	401	ARG
1	A	407	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	260	ASN
1	A	272	ASN
1	A	274	GLN
1	A	295	HIS
1	A	307	HIS
1	A	327	HIS
1	A	380	GLN
1	A	385	GLN
1	A	396	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 monosaccharides in this entry.

5.6 Ligand geometry (i)

1 ligand is modelled in this entry.

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	CIT	A	500	-	12,12,12	1.39	1 (8%)	17,17,17	1.34	2 (11%)

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	CIT	A	500	-	-	0/16/16/16	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	500	CIT	C3-C6	-2.47	1.50	1.53

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	A	500	CIT	O6-C6-C3	3.09	118.41	113.05
2	A	500	CIT	C2-C3-C6	-2.38	104.99	110.11

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 (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	336/346 (97%)	1.28	82 (24%) 0 0	20, 28, 61, 68	0

All (82) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	224	SER	10.8
1	A	186	GLY	10.3
1	A	185	GLU	9.9
1	A	271	GLY	9.6
1	A	431	HIS	8.9
1	A	184	LYS	8.1
1	A	225	ARG	8.0
1	A	233	ASP	7.6
1	A	187	GLY	7.4
1	A	429	TYR	7.3
1	A	398[A]	LEU	7.3
1	A	232	LYS	6.9
1	A	216	GLU	6.8
1	A	272	ASN	6.7
1	A	183	ARG	6.6
1	A	119	GLU	6.5
1	A	397	LEU	6.4
1	A	269	ALA	6.3
1	A	401	ARG	5.3
1	A	220	LYS	5.1
1	A	235	LYS	4.9
1	A	217	GLU	4.9
1	A	435	GLU	4.8
1	A	432	SER	4.8
1	A	259	PHE	4.8
1	A	270[A]	ASP	4.7
1	A	399	TYR	4.6

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Mol	Chain	Res	Type	RSRZ
1	A	436	ASN	4.5
1	A	405	PHE	4.4
1	A	257	ILE	4.4
1	A	227	LYS	4.4
1	A	223	ARG	4.2
1	A	231	THR	4.2
1	A	221	GLN	4.2
1	A	234	GLY	4.2
1	A	403	THR	4.0
1	A	247	ILE	3.8
1	A	122	GLU	3.7
1	A	125	HIS	3.7
1	A	219	ALA	3.5
1	A	243	VAL	3.5
1	A	337	ILE	3.4
1	A	281	CYS	3.4
1	A	334	ILE	3.3
1	A	283	LEU	3.3
1	A	120	GLU	3.3
1	A	175	ASN	3.2
1	A	402	GLY	3.1
1	A	230	LYS	3.0
1	A	246	VAL	2.9
1	A	205	VAL	2.9
1	A	226	GLY	2.8
1	A	218	ALA	2.8
1	A	169[A]	GLN	2.8
1	A	327	HIS	2.8
1	A	214	LEU	2.7
1	A	215	SER	2.7
1	A	414	ILE	2.6
1	A	411	GLY	2.6
1	A	430	MET	2.6
1	A	256	THR	2.6
1	A	261	TYR	2.6
1	A	284	THR	2.6
1	A	244[A]	SER	2.6
1	A	361	VAL	2.5
1	A	207	ILE	2.4
1	A	419	MET	2.4
1	A	144	ARG	2.4
1	A	288	LEU	2.3

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Mol	Chain	Res	Type	RSRZ
1	A	137	ASP	2.2
1	A	273	LYS	2.2
1	A	163	VAL	2.2
1	A	404	LYS	2.2
1	A	245	SER	2.2
1	A	212	GLY	2.2
1	A	280	GLY	2.1
1	A	203	ALA	2.1
1	A	121	ASP	2.1
1	A	258	HIS	2.1
1	A	408	PHE	2.1
1	A	255	PRO	2.0
1	A	434	SER	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 monosaccharides 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	CIT	A	500	13/13	0.81	0.19	28,33,38,39	0

6.5 Other polymers (i)

There are no such residues in this entry.