



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 08:08 PM UTC

PDB ID : 1SQG / pdb_00001sqg
Title : The crystal structure of the E. coli Fmu apoenzyme at 1.65 Å resolution
Authors : Foster, P.G.; Nunes, C.R.; Greene, P.; Moustakas, D.; Stroud, R.M.
Deposited on : 2004-03-18
Resolution : 1.65 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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

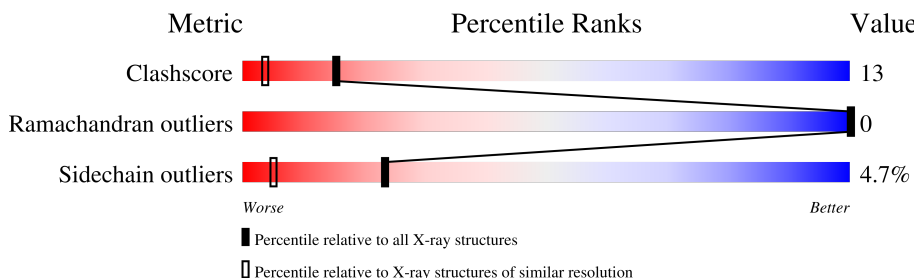
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.65 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))
Clashscore	190562	2662 (1.66-1.66)
Ramachandran outliers	187476	2621 (1.66-1.66)
Sidechain outliers	187428	2621 (1.66-1.66)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	429	 78% 18% ..

2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 3678 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 SUN protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	424	Total	C	N	O	S	0	1	0
			3288	2084	591	598	15			

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	390	Total	O	0	0
			390	390		

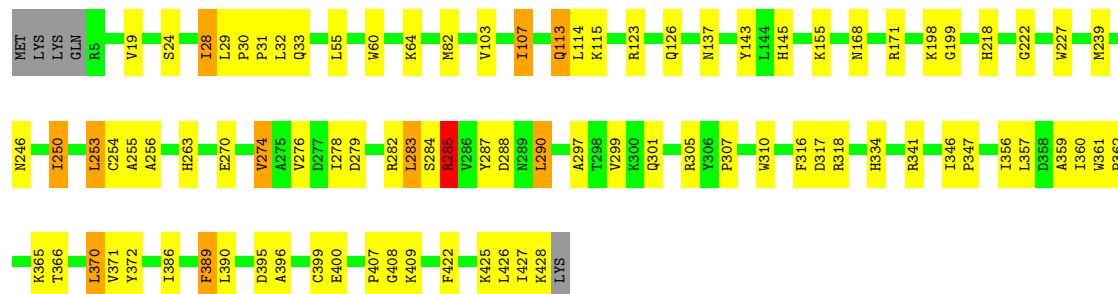
3 Residue-property plots [i](#)

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. 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. 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.

Note EDS was not executed.

- Molecule 1: SUN protein

Chain A:  78% 18% ..



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	59.67Å 48.70Å 86.80Å 90.00° 108.65° 90.00°	Depositor
Resolution (Å)	30.00 – 1.65	Depositor
% Data completeness (in resolution range)	98.7 (30.00-1.65)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	0.04	Depositor
Refinement program	REFMAC 5.0	Depositor
R, R_{free}	0.223 , 0.257	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	3678	wwPDB-VP
Average B, all atoms (Å ²)	10.0	wwPDB-VP

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	0.67	3/3369 (0.1%)	0.92	7/4583 (0.2%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	285	ARG	NE-CZ	15.54	1.50	1.33
1	A	171	ARG	NE-CZ	13.44	1.47	1.33
1	A	171	ARG	CD-NE	5.38	1.53	1.46

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	285	ARG	CD-NE-CZ	-10.15	110.19	124.40
1	A	278	ILE	N-CA-C	8.52	119.09	110.23
1	A	171	ARG	CD-NE-CZ	-8.42	112.61	124.40
1	A	400	GLU	N-CA-C	5.46	122.44	110.80
1	A	279	ASP	N-CA-C	5.46	117.71	109.41
1	A	255	ALA	N-CA-C	5.12	118.69	112.23
1	A	19	VAL	N-CA-C	5.06	115.83	110.72

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	3288	0	3236	88	0
2	A	390	0	0	8	0
All	All	3678	0	3236	88	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 13.

All (88) 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:370:LEU:C	1:A:370:LEU:HD23	1.72	1.13
1:A:287:TYR:CE1	1:A:299:VAL:HG11	1.85	1.09
1:A:30:PRO:HB2	1:A:31:PRO:HD3	1.40	1.01
1:A:113:GLN:HE21	1:A:113:GLN:H	1.09	0.99
1:A:409:LYS:NZ	2:A:693:HOH:O	1.98	0.95
1:A:399:CYS:O	1:A:425:LYS:CG	2.20	0.89
1:A:370:LEU:HD22	1:A:426:LEU:HD12	1.57	0.85
1:A:370:LEU:HD23	1:A:370:LEU:O	1.75	0.84
1:A:145:HIS:HE1	1:A:168:ASN:HD22	1.24	0.83
1:A:113:GLN:H	1:A:113:GLN:NE2	1.78	0.80
1:A:28:ILE:HD11	1:A:32:LEU:HD11	1.63	0.80
1:A:370:LEU:CD2	1:A:426:LEU:HD12	2.12	0.79
1:A:287:TYR:CE1	1:A:299:VAL:CG1	2.67	0.77
1:A:370:LEU:C	1:A:370:LEU:CD2	2.51	0.74
1:A:408:GLY:O	2:A:654:HOH:O	2.06	0.73
1:A:274:VAL:HG11	1:A:316:PHE:CE2	2.25	0.72
1:A:30:PRO:HB2	1:A:31:PRO:CD	2.19	0.71
1:A:284:SER:O	1:A:288:ASP:OD2	2.10	0.69
1:A:290:LEU:HD21	1:A:297:ALA:HB3	1.75	0.69
1:A:113:GLN:HE21	1:A:113:GLN:N	1.89	0.68
1:A:287:TYR:CZ	1:A:299:VAL:HG11	2.29	0.67
1:A:246:ASN:HB3	1:A:270:GLU:HB2	1.79	0.65
1:A:145:HIS:CE1	1:A:168:ASN:HD22	2.10	0.65
1:A:361:TRP:N	1:A:362:PRO:HD2	2.14	0.62
1:A:55:LEU:HD11	1:A:82:MET:HE1	1.82	0.60
1:A:250:ILE:HD13	1:A:318:ARG:HB2	1.82	0.60
1:A:256:ALA:CB	1:A:282:ARG:HB3	2.31	0.60
1:A:28:ILE:HD11	1:A:32:LEU:CD1	2.30	0.60
1:A:372:TYR:CD2	1:A:386:ILE:HD11	2.37	0.59
1:A:389:PHE:CZ	1:A:396:ALA:HB1	2.37	0.59
1:A:282:ARG:HH11	1:A:282:ARG:HG3	1.67	0.58
1:A:389:PHE:CZ	1:A:396:ALA:CB	2.86	0.58

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:198:LYS:HD2	1:A:199:GLY:H	1.69	0.57
1:A:389:PHE:HZ	1:A:396:ALA:HB1	1.69	0.57
1:A:143:TYR:O	1:A:145:HIS:HD2	1.89	0.56
1:A:256:ALA:HB2	1:A:282:ARG:HB3	1.86	0.56
1:A:28:ILE:CD1	1:A:32:LEU:HD11	2.36	0.56
1:A:389:PHE:CD1	1:A:390:LEU:N	2.74	0.56
1:A:218:HIS:HD2	2:A:746:HOH:O	1.88	0.55
1:A:282:ARG:HA	1:A:285:ARG:HD2	1.89	0.55
1:A:198:LYS:HD2	1:A:199:GLY:N	2.23	0.54
1:A:123:ARG:HD2	1:A:126:GLN:HE21	1.72	0.53
1:A:137:ASN:OD1	2:A:544:HOH:O	2.19	0.52
1:A:282:ARG:HG3	1:A:282:ARG:NH1	2.20	0.52
1:A:305:ARG:HG3	1:A:356:ILE:HD11	1.91	0.52
1:A:30:PRO:CB	1:A:31:PRO:HD3	2.25	0.52
1:A:370:LEU:O	1:A:370:LEU:CD2	2.52	0.50
1:A:123:ARG:HD2	1:A:126:GLN:NE2	2.27	0.50
1:A:341:ARG:NE	1:A:341:ARG:HA	2.26	0.50
1:A:287:TYR:CZ	1:A:299:VAL:CG1	2.93	0.50
1:A:107:ILE:HD12	1:A:107:ILE:O	2.12	0.49
1:A:361:TRP:CZ2	1:A:428:LYS:HB2	2.47	0.48
1:A:239:MET:HG2	1:A:263:HIS:CD2	2.49	0.48
1:A:334:HIS:HE1	2:A:679:HOH:O	1.97	0.48
1:A:305:ARG:HG3	1:A:356:ILE:CD1	2.44	0.47
1:A:115:LYS:HB3	1:A:115:LYS:NZ	2.30	0.47
1:A:389:PHE:CD1	1:A:389:PHE:C	2.90	0.47
1:A:155:LYS:HD3	2:A:666:HOH:O	2.14	0.47
1:A:274:VAL:HG11	1:A:316:PHE:HE2	1.76	0.47
1:A:316:PHE:O	1:A:365:LYS:HG2	2.15	0.47
1:A:107:ILE:HD12	1:A:107:ILE:C	2.40	0.46
1:A:370:LEU:HD23	1:A:371:VAL:N	2.26	0.46
1:A:253:LEU:O	1:A:254:CYS:HB2	2.15	0.46
1:A:346:ILE:HB	1:A:347:PRO:HD3	1.97	0.46
1:A:28:ILE:HD12	2:A:558:HOH:O	2.16	0.46
1:A:29:LEU:HD22	1:A:33:GLN:HG3	1.99	0.44
1:A:370:LEU:HD22	1:A:426:LEU:HB2	1.99	0.44
1:A:386:ILE:HB	1:A:407:PRO:HB2	2.00	0.44
1:A:103:VAL:HG12	1:A:115:LYS:HE2	1.99	0.44
1:A:408:GLY:HA3	1:A:422:PHE:CZ	2.53	0.44
1:A:113:GLN:HG2	1:A:114:LEU:CD2	2.48	0.43
1:A:370:LEU:HD21	1:A:426:LEU:HD12	1.93	0.43
1:A:253:LEU:HD12	1:A:360:ILE:HG12	2.00	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:115:LYS:HE3	2:A:759:HOH:O	2.19	0.42
1:A:274:VAL:CG1	1:A:316:PHE:CE2	3.00	0.42
1:A:30:PRO:CB	1:A:31:PRO:CD	2.89	0.42
1:A:317:ASP:OD2	1:A:365:LYS:HD2	2.19	0.42
1:A:60:TRP:CZ2	1:A:64:LYS:HE2	2.54	0.42
1:A:361:TRP:N	1:A:362:PRO:CD	2.83	0.41
1:A:365:LYS:O	1:A:428:LYS:NZ	2.53	0.41
1:A:395:ASP:O	1:A:428:LYS:HA	2.20	0.41
1:A:360:ILE:C	1:A:362:PRO:HD2	2.45	0.41
1:A:24:SER:O	1:A:28:ILE:HG23	2.21	0.41
1:A:55:LEU:CD1	1:A:82:MET:HE1	2.50	0.40
1:A:283:LEU:HD12	1:A:283:LEU:HA	1.57	0.40
1:A:307:PRO:HA	1:A:310:TRP:CE2	2.57	0.40
1:A:222:GLY:HA3	1:A:227:TRP:CE3	2.56	0.40
1:A:307:PRO:HG2	1:A:359:ALA:O	2.21	0.40

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	423/429 (99%)	416 (98%)	7 (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	339/362 (94%)	323 (95%)	16 (5%)	23 5

All (16) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	28	ILE
1	A	107	ILE
1	A	113	GLN
1	A	250	ILE
1	A	253	LEU
1	A	274	VAL
1	A	276	VAL
1	A	283	LEU
1	A	285	ARG
1	A	290	LEU
1	A	301	GLN
1	A	357	LEU
1	A	366	THR
1	A	370	LEU
1	A	389	PHE
1	A	427	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (14) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	57	GLN
1	A	113	GLN
1	A	119	ASN
1	A	126	GLN
1	A	137	ASN
1	A	145	HIS
1	A	154	GLN
1	A	170	GLN
1	A	236	GLN
1	A	263	HIS
1	A	272	GLN
1	A	334	HIS
1	A	351	GLN
1	A	391	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 ⓘ

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates ⓘ

EDS was not executed - this section is therefore empty.

6.4 Ligands ⓘ

EDS was not executed - this section is therefore empty.

6.5 Other polymers ⓘ

EDS was not executed - this section is therefore empty.