



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 06:54 AM UTC

PDB ID : 4S2U / pdb_00004s2u
Title : Crystal structure of the Phosphorybosylpyrophosphate synthetase from E. Coli
Authors : Timofeev, V.I.; Abramchik, Y.A.; Muravieva, T.I.; Iaroslavtceva, A.K.; Stepanenko, V.N.; Zhukhlistova, N.E.; Esipov, R.S.; Kuranova, I.P.
Deposited on : 2015-01-23
Resolution : 2.71 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

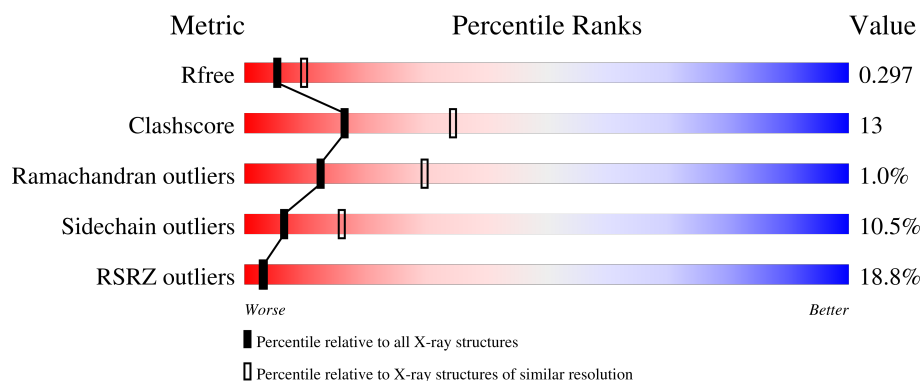
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.71 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	4348 (2.74-2.70)
Clashscore	190562	4665 (2.74-2.70)
Ramachandran outliers	187476	4584 (2.74-2.70)
Sidechain outliers	187428	4585 (2.74-2.70)
RSRZ outliers	180081	4348 (2.74-2.70)

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	316	18% 70% 23% . .

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2351 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 Ribose-phosphate pyrophosphokinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	308	Total	C	N	O	S	0	0	0
			2339	1458	422	447	12			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	0	MET	-	expression tag	UNP G4PTS0
A	1	ALA	-	expression tag	UNP G4PTS0

- 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		

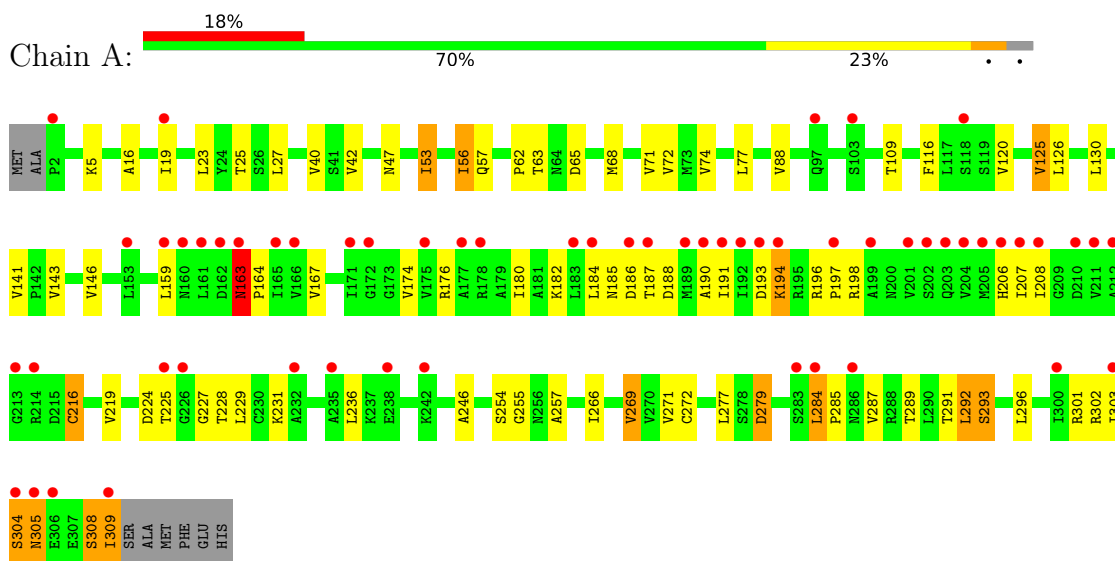
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	11	Total	O	0	0
			11	11		

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: Ribose-phosphate pyrophosphokinase



4 Data and refinement statistics

Property	Value	Source
Space group	P 63 2 2	Depositor
Cell constants a, b, c, α , β , γ	104.60Å 104.60Å 125.78Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	29.36 – 2.71 29.36 – 2.71	Depositor EDS
% Data completeness (in resolution range)	94.4 (29.36-2.71) 94.4 (29.36-2.71)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.09	Depositor
$\langle I/\sigma(I) \rangle$ ¹	6.01 (at 2.72Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.250 , 0.304 0.253 , 0.297	Depositor DCC
R_{free} test set	521 reflections (4.50%)	wwPDB-VP
Wilson B-factor (Å ²)	45.8	Xtriage
Anisotropy	0.404	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 46.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	2351	wwPDB-VP
Average B, all atoms (Å ²)	52.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.34% 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

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	0.61	0/2368	0.92	5/3213 (0.2%)

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	A	0	1

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
1	A	163	ASN	CA-C-N	5.92	141.20	127.00
1	A	163	ASN	C-N-CA	5.92	141.20	127.00
1	A	216	CYS	N-CA-C	5.61	118.12	110.55
1	A	196	ARG	N-CA-C	-5.47	102.04	110.58
1	A	163	ASN	C-N-CD	-5.41	108.70	120.60

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	304	SER	Peptide

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	2339	0	2381	61	0
2	A	1	0	0	0	0
3	A	11	0	0	0	0
All	All	2351	0	2381	61	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 (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:A:187:THR:HB	1:A:188:ASP:CB	2.22	0.70
1:A:197:PRO:HB2	1:A:198:ARG:HB3	1.74	0.70
1:A:71:VAL:HG11	1:A:116:PHE:CZ	2.27	0.69
1:A:187:THR:HB	1:A:188:ASP:CG	2.18	0.68
1:A:163:ASN:HB3	1:A:164:PRO:HA	1.74	0.68
1:A:174:VAL:HG22	1:A:191:ILE:HD12	1.78	0.66
1:A:224:ASP:C	1:A:225:THR:HG23	2.21	0.66
1:A:224:ASP:OD1	1:A:254:SER:OG	2.08	0.65
1:A:193:ASP:HA	1:A:194:LYS:HB3	1.79	0.64
1:A:277:LEU:HD11	1:A:289:THR:CG2	2.29	0.63
1:A:304:SER:N	1:A:305:ASN:HA	2.14	0.62
1:A:191:ILE:HG12	1:A:208:ILE:HD11	1.82	0.62
1:A:269:VAL:HG13	1:A:287:VAL:HG12	1.82	0.62
1:A:56:ILE:HD12	1:A:57:GLN:N	2.15	0.61
1:A:56:ILE:HD12	1:A:56:ILE:C	2.27	0.60
1:A:19:ILE:HD11	1:A:56:ILE:HG21	1.84	0.60
1:A:225:THR:O	1:A:257:ALA:HA	2.01	0.59
1:A:180:ILE:HD13	1:A:219:VAL:HG21	1.86	0.58
1:A:190:ALA:O	1:A:191:ILE:HD13	2.04	0.57
1:A:53:ILE:CD1	1:A:77:LEU:HD13	2.38	0.54
1:A:301:ARG:O	1:A:304:SER:HB2	2.08	0.54
1:A:301:ARG:O	1:A:304:SER:N	2.41	0.54
1:A:304:SER:H	1:A:305:ASN:HA	1.73	0.53
1:A:277:LEU:HD11	1:A:289:THR:HG21	1.91	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:194:LYS:O	1:A:194:LYS:HD2	2.08	0.53
1:A:197:PRO:HB2	1:A:198:ARG:CB	2.39	0.52
1:A:302:ARG:C	1:A:304:SER:H	2.18	0.51
1:A:74:VAL:HG11	1:A:120:VAL:HG13	1.92	0.51
1:A:284:LEU:HD23	1:A:285:PRO:HD2	1.93	0.50
1:A:125:VAL:CG2	1:A:143:VAL:HG13	2.42	0.49
1:A:16:ALA:O	1:A:19:ILE:HG12	2.13	0.49
1:A:271:VAL:O	1:A:289:THR:HA	2.13	0.48
1:A:193:ASP:HA	1:A:194:LYS:CB	2.44	0.48
1:A:302:ARG:O	1:A:305:ASN:HA	2.15	0.47
1:A:125:VAL:HG22	1:A:143:VAL:HG22	1.97	0.47
1:A:167:VAL:HG13	1:A:190:ALA:HB3	1.96	0.46
1:A:68:MET:O	1:A:72:VAL:HG13	2.15	0.46
1:A:62:PRO:HB2	1:A:65:ASP:HB2	1.97	0.46
1:A:224:ASP:O	1:A:225:THR:OG1	2.30	0.46
1:A:74:VAL:CG1	1:A:120:VAL:HG13	2.47	0.45
1:A:180:ILE:CD1	1:A:219:VAL:HG21	2.47	0.45
1:A:53:ILE:HD11	1:A:77:LEU:HD13	1.98	0.45
1:A:309:ILE:HD12	1:A:309:ILE:O	2.16	0.45
1:A:187:THR:HB	1:A:188:ASP:CA	2.48	0.44
1:A:182:LYS:O	1:A:184:LEU:O	2.36	0.44
1:A:272:CYS:HB3	1:A:292:LEU:HD22	1.99	0.44
1:A:23:LEU:O	1:A:25:THR:HG23	2.18	0.43
1:A:42:VAL:HG21	1:A:72:VAL:HG23	2.00	0.43
1:A:197:PRO:HB2	1:A:198:ARG:CA	2.49	0.43
1:A:279:ASP:OD1	1:A:279:ASP:N	2.52	0.43
1:A:207:ILE:HG22	1:A:208:ILE:N	2.34	0.42
1:A:291:THR:HB	1:A:293:SER:OG	2.20	0.42
1:A:185:ASN:N	1:A:185:ASN:HD22	2.18	0.42
1:A:186:ASP:HA	1:A:187:THR:C	2.45	0.42
1:A:194:LYS:O	1:A:194:LYS:CG	2.68	0.42
1:A:216:CYS:SG	1:A:236:LEU:HD22	2.60	0.41
1:A:5:LYS:NZ	1:A:47:ASN:O	2.54	0.41
1:A:227:GLY:O	1:A:231:LYS:HD3	2.20	0.41
1:A:229:LEU:HD23	1:A:246:ALA:HB1	2.01	0.41
1:A:125:VAL:HG22	1:A:143:VAL:HG13	2.04	0.40
1:A:308:SER:HA	1:A:309:ILE:C	2.47	0.40

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone

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	306/316 (97%)	269 (88%)	34 (11%)	3 (1%)	12	30

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	163	ASN
1	A	255	GLY
1	A	303	ILE

5.3.2 Protein sidechains

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	256/262 (98%)	229 (90%)	27 (10%)	6	16

All (27) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	27	LEU
1	A	40	VAL
1	A	53	ILE
1	A	56	ILE
1	A	63	THR
1	A	88	VAL
1	A	109	THR
1	A	125	VAL

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Mol	Chain	Res	Type
1	A	126	LEU
1	A	130	LEU
1	A	141	VAL
1	A	146	VAL
1	A	159	LEU
1	A	176	ARG
1	A	194	LYS
1	A	206	HIS
1	A	228	THR
1	A	266	ILE
1	A	269	VAL
1	A	279	ASP
1	A	284	LEU
1	A	292	LEU
1	A	293	SER
1	A	296	LEU
1	A	305	ASN
1	A	308	SER
1	A	309	ILE

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	21	ASN
1	A	64	ASN
1	A	163	ASN
1	A	185	ASN
1	A	206	HIS
1	A	256	ASN
1	A	259	ASN
1	A	263	ASN
1	A	305	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 [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 1 ligands modelled in this entry, 1 is 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, 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	308/316 (97%)	0.93	58 (18%) 3 3	23, 45, 102, 136	0

All (58) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	204	VAL	6.2
1	A	201	VAL	6.2
1	A	161	LEU	5.0
1	A	199	ALA	5.0
1	A	203	GLN	5.0
1	A	202	SER	4.9
1	A	208	ILE	4.7
1	A	226	GLY	4.6
1	A	214	ARG	4.6
1	A	213	GLY	4.4
1	A	193	ASP	4.3
1	A	197	PRO	4.0
1	A	309	ILE	4.0
1	A	189	MET	3.9
1	A	304	SER	3.6
1	A	187	THR	3.6
1	A	194	LYS	3.6
1	A	165	ILE	3.6
1	A	191	ILE	3.6
1	A	225	THR	3.4
1	A	163	ASN	3.3
1	A	205	MET	3.3
1	A	178	ARG	3.2
1	A	162	ASP	3.2
1	A	212	ALA	3.1
1	A	207	ILE	3.1
1	A	2	PRO	3.0

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Mol	Chain	Res	Type	RSRZ
1	A	306	GLU	2.9
1	A	283	SER	2.9
1	A	192	ILE	2.8
1	A	103	SER	2.8
1	A	186	ASP	2.8
1	A	210	ASP	2.8
1	A	206	HIS	2.7
1	A	211	VAL	2.7
1	A	97	GLN	2.6
1	A	171	ILE	2.6
1	A	159	LEU	2.6
1	A	172	GLY	2.5
1	A	118	SER	2.4
1	A	183	LEU	2.4
1	A	284	LEU	2.3
1	A	175	VAL	2.3
1	A	153	LEU	2.3
1	A	300	ILE	2.3
1	A	303	ILE	2.2
1	A	184	LEU	2.2
1	A	177	ALA	2.2
1	A	190	ALA	2.2
1	A	160	ASN	2.2
1	A	232	ALA	2.2
1	A	286	ASN	2.2
1	A	19	ILE	2.1
1	A	238	GLU	2.1
1	A	242	LYS	2.1
1	A	235	ALA	2.0
1	A	305	ASN	2.0
1	A	166	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

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	MG	A	401	1/1	0.95	0.21	25,25,25,25	0

6.5 Other polymers

There are no such residues in this entry.