



wwPDB X-ray Structure Validation Summary Report i

Feb 28, 2014 – 02:38 AM GMT

PDB ID : 2AJQ
Title : Structure of replicative DNA polymerase provides insights into the mechanisms for processivity, frameshifting and editing
Authors : Briebe, L.; Ellenberger, T.
Deposited on : 2005-08-02
Resolution : 2.60 Å (reported)

This is a wwPDB validation summary report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at <http://wwpdb.org/ValidationPDFNotes.html>

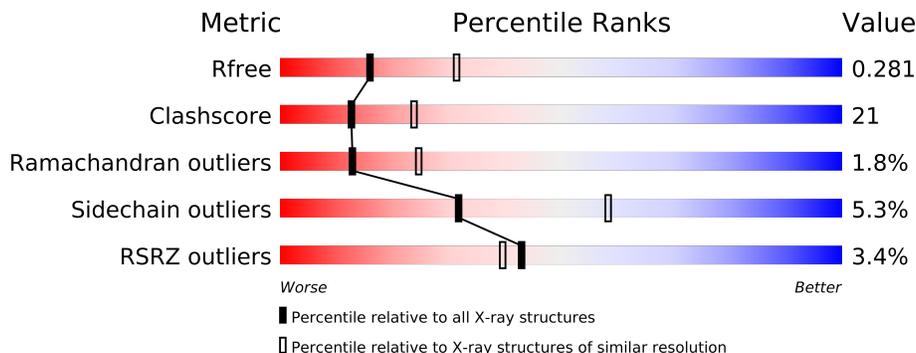
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.15 2013
Xtriage (Phenix) : dev-1323
EDS : stable22639
Percentile statistics : 21963
Refmac : 5.8.0049
CCP4 : 6.3.0 (Settle)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)
Validation Pipeline (wwPDB-VP) : stable22683

1 Overall quality at a glance

The reported resolution of this entry is 2.60 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} | 66092 | 1718 (2.60-2.60) |
| Clashscore | 79885 | 2154 (2.60-2.60) |
| Ramachandran outliers | 78287 | 2113 (2.60-2.60) |
| Sidechain outliers | 78261 | 2113 (2.60-2.60) |
| RSRZ outliers | 66119 | 1718 (2.60-2.60) |

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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

| Mol | Chain | Length | Quality of chain |
|-----|-------|--------|------------------|
| 1 | P | 22 | |
| 1 | X | 22 | |
| 2 | T | 26 | |
| 2 | Z | 26 | |
| 3 | A | 704 | |
| 3 | F | 704 | |
| 4 | B | 108 | |
| 4 | I | 108 | |

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 14791 atoms, of which 0 are hydrogen and 0 are deuterium.

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 DNA chain called DNA Primer.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|-----|----|-----|----|---------|---------|-------|
| | | | Total | C | N | O | P | | | |
| 1 | P | 20 | 390 | 184 | 77 | 110 | 19 | 0 | 0 | 1 |
| 1 | X | 21 | 432 | 204 | 87 | 120 | 21 | 0 | 0 | 0 |

- Molecule 2 is a DNA chain called DNA Template.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|-----|----|-----|----|---------|---------|-------|
| | | | Total | C | N | O | P | | | |
| 2 | T | 22 | 453 | 215 | 79 | 137 | 22 | 0 | 0 | 0 |
| 2 | Z | 25 | 514 | 244 | 89 | 156 | 25 | 0 | 0 | 0 |

- Molecule 3 is a protein called T7 DNA polymerase.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|------|-----|------|----|---------|---------|-------|
| | | | Total | C | N | O | S | | | |
| 3 | A | 704 | 5541 | 3527 | 971 | 1019 | 24 | 0 | 0 | 0 |
| 3 | F | 689 | 5459 | 3480 | 953 | 1003 | 23 | 0 | 0 | 0 |

There are 4 discrepancies between the modelled and reference sequences:

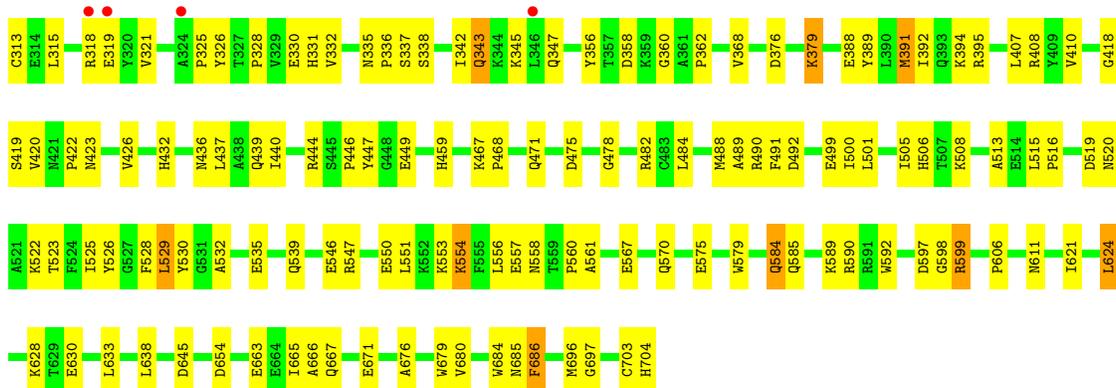
| Chain | Residue | Modelled | Actual | Comment | Reference |
|-------|---------|----------|--------|------------|------------|
| A | 5 | ALA | ASP | ENGINEERED | UNP P00581 |
| A | 7 | ALA | GLU | ENGINEERED | UNP P00581 |
| F | 5 | ALA | ASP | ENGINEERED | UNP P00581 |
| F | 7 | ALA | GLU | ENGINEERED | UNP P00581 |

- Molecule 4 is a protein called thioredoxin 1.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|-----|-----|-----|---|---------|---------|-------|
| 4 | B | 105 | Total | C | N | O | S | 0 | 0 | 0 |
| | | | 799 | 517 | 129 | 150 | 3 | | | |
| 4 | I | 105 | Total | C | N | O | S | 0 | 0 | 0 |
| | | | 789 | 512 | 126 | 148 | 3 | | | |

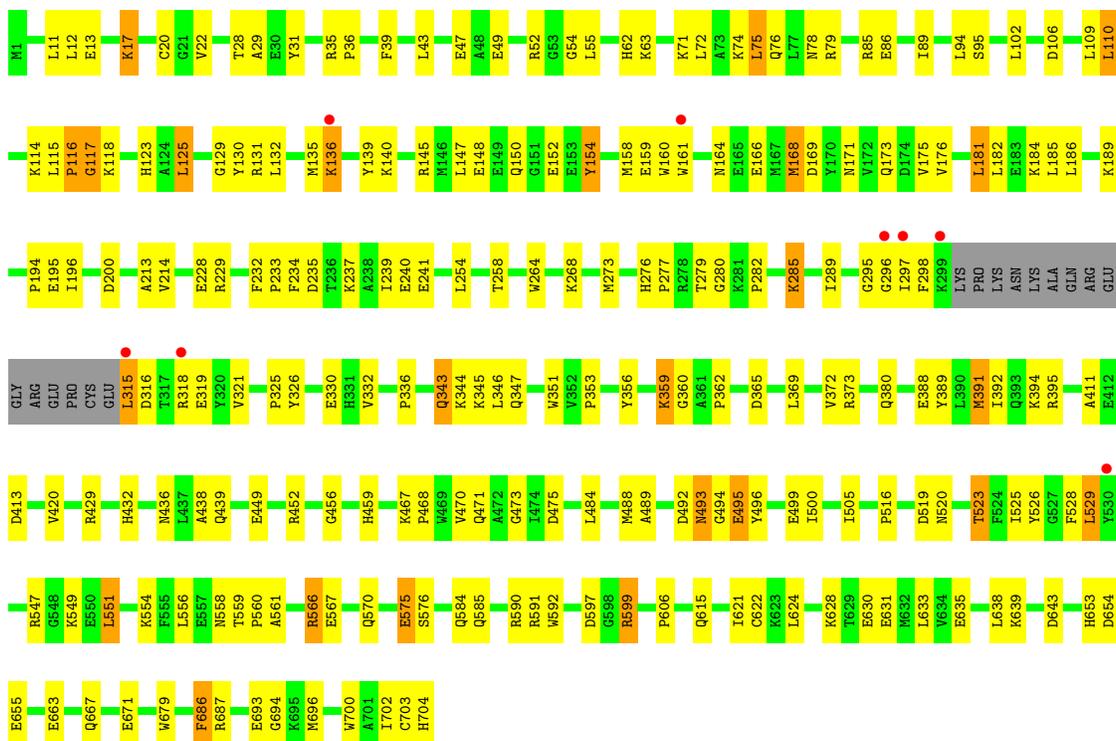
- Molecule 5 is water.

| Mol | Chain | Residues | Atoms | | ZeroOcc | AltConf |
|-----|-------|----------|-------|-----|---------|---------|
| 5 | P | 16 | Total | O | 0 | 0 |
| | | | 16 | 16 | | |
| 5 | T | 21 | Total | O | 0 | 0 |
| | | | 21 | 21 | | |
| 5 | X | 21 | Total | O | 0 | 0 |
| | | | 21 | 21 | | |
| 5 | Z | 27 | Total | O | 0 | 0 |
| | | | 27 | 27 | | |
| 5 | A | 158 | Total | O | 0 | 0 |
| | | | 158 | 158 | | |
| 5 | B | 13 | Total | O | 0 | 0 |
| | | | 13 | 13 | | |
| 5 | F | 142 | Total | O | 0 | 0 |
| | | | 142 | 142 | | |
| 5 | I | 16 | Total | O | 0 | 0 |
| | | | 16 | 16 | | |



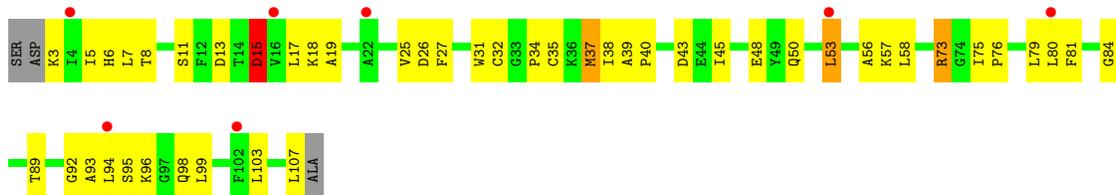
• Molecule 3: T7 DNA polymerase

Chain F:



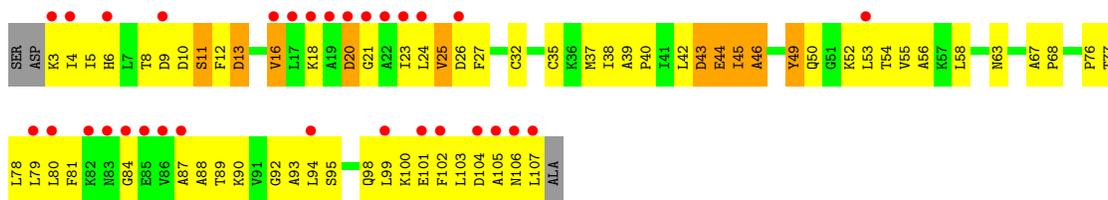
• Molecule 4: thioredoxin 1

Chain B:



• Molecule 4: thioredoxin 1

Chain I:



4 Data and refinement statistics (i)

| Property | Value | Source |
|---|---|------------------|
| Space group | C 2 2 21 | Depositor |
| Cell constants a, b, c, α , β , γ | 168.31Å 169.24Å 179.79Å 90.00° 90.00° 90.00° | Depositor |
| Resolution (Å) | 45.97 – 2.60 45.97 – 2.38 | Depositor EDS |
| % Data completeness (in resolution range) | 99.8 (45.97-2.60) 95.7 (45.97-2.38) | Depositor EDS |
| R_{merge} | 0.09 | Depositor |
| R_{sym} | 0.11 | Depositor |
| $\langle I/\sigma(I) \rangle$ ¹ | 1.93 (at 2.37Å) | Xtriage |
| Refinement program | CNS 1.1 | Depositor |
| R, R_{free} | 0.233 , 0.284 0.239 , 0.281 | Depositor DCC |
| R_{free} test set | 3929 reflections (4.99%) | DCC |
| Wilson B-factor (Å ²) | 60.0 | Xtriage |
| Anisotropy | 0.315 | Xtriage |
| Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²) | 0.31 , 38.9 | EDS |
| Estimated twinning fraction | 0.449 for -k,-h,-l | Xtriage |
| L-test for twinning | $\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$ | Xtriage |
| Outliers | 1 of 98459 reflections (0.001%) | Xtriage |
| F_o, F_c correlation | 0.95 | EDS |
| Total number of atoms | 14791 | wwPDB-VP |
| Average B, all atoms (Å ²) | 74.0 | wwPDB-VP |

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.61% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

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: 2DT

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 | P | 0.66 | 1/417 (0.2%) | 0.90 | 1/642 (0.2%) |
| 1 | X | 0.41 | 0/465 | 0.81 | 0/715 |
| 2 | T | 0.55 | 0/506 | 0.83 | 0/780 |
| 2 | Z | 0.46 | 0/574 | 0.77 | 0/885 |
| 3 | A | 0.39 | 0/5680 | 0.59 | 0/7693 |
| 3 | F | 0.39 | 0/5594 | 0.60 | 0/7570 |
| 4 | B | 0.31 | 0/814 | 0.55 | 0/1104 |
| 4 | I | 0.32 | 0/803 | 0.55 | 0/1089 |
| All | All | 0.40 | 1/14853 (0.0%) | 0.63 | 1/20478 (0.0%) |

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 | P | 0 | 2 |
| 1 | X | 0 | 2 |
| 2 | T | 0 | 4 |
| 2 | Z | 0 | 2 |
| All | All | 0 | 10 |

All (1) bond length outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(Å) | Ideal(Å) |
|-----|-------|-----|------|-------|-------|-------------|----------|
| 1 | P | 803 | DA | O3'-P | -7.13 | 1.52 | 1.61 |

All (1) bond angle outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(°) | Ideal(°) |
|-----|-------|-----|------|------------|-------|-------------|----------|
| 1 | P | 821 | DA | N9-C1'-C2' | -5.54 | 102.08 | 112.60 |

There are no chirality outliers.

5 of 10 planarity outliers are listed below:

| Mol | Chain | Res | Type | Group |
|-----|-------|-----|------|-----------|
| 1 | P | 820 | DC | Sidechain |
| 1 | P | 821 | DA | Sidechain |
| 2 | T | 854 | DG | Sidechain |
| 2 | T | 855 | DA | Sidechain |
| 2 | T | 856 | DT | Sidechain |

5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

| Mol | Chain | Non-H | H(model) | H(added) | Clashes | Symm-Clashes |
|-----|-------|-------|----------|----------|---------|--------------|
| 1 | P | 390 | 0 | 212 | 37 | 0 |
| 1 | X | 432 | 0 | 234 | 29 | 0 |
| 2 | T | 453 | 0 | 250 | 21 | 0 |
| 2 | Z | 514 | 0 | 284 | 13 | 0 |
| 3 | A | 5541 | 0 | 5382 | 186 | 0 |
| 3 | F | 5459 | 0 | 5338 | 179 | 0 |
| 4 | B | 799 | 0 | 814 | 45 | 0 |
| 4 | I | 789 | 0 | 794 | 92 | 0 |
| 5 | A | 158 | 0 | 0 | 14 | 0 |
| 5 | B | 13 | 0 | 0 | 1 | 0 |
| 5 | F | 142 | 0 | 0 | 7 | 1 |
| 5 | I | 16 | 0 | 0 | 4 | 0 |
| 5 | P | 16 | 0 | 0 | 0 | 0 |
| 5 | T | 21 | 0 | 0 | 0 | 0 |
| 5 | X | 21 | 0 | 0 | 0 | 0 |
| 5 | Z | 27 | 0 | 0 | 0 | 0 |
| All | All | 14791 | 0 | 13308 | 577 | 1 |

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 21.

The worst 5 of 577 close contacts within the same asymmetric unit are listed below.

| Atom-1 | Atom-2 | Distance(Å) | Clash(Å) |
|-----------------|-----------------|-------------|----------|
| 4:B:73:ARG:HH11 | 4:B:73:ARG:HB3 | 1.11 | 1.09 |
| 2:T:867:DG:H2'' | 2:T:868:DT:H5' | 1.32 | 1.07 |
| 4:I:16:VAL:HA | 4:I:23:ILE:HG21 | 1.36 | 1.04 |
| 1:P:807:DC:H2'' | 1:P:808:DG:H5' | 1.38 | 1.03 |
| 4:B:73:ARG:NH1 | 4:B:73:ARG:HB3 | 1.79 | 0.96 |

All (1) 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 | Distance(Å) | Clash(Å) |
|----------------|-----------------------|-------------|----------|
| 5:F:5072:HOH:O | 5:F:5072:HOH:O[3.555] | 1.46 | 0.74 |

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 | |
|-----|-------|-----------------|------------|----------|----------|-------------|----|
| 3 | A | 702/704 (100%) | 657 (94%) | 39 (6%) | 6 (1%) | 25 | 49 |
| 3 | F | 685/704 (97%) | 635 (93%) | 43 (6%) | 7 (1%) | 22 | 45 |
| 4 | B | 103/108 (95%) | 89 (86%) | 10 (10%) | 4 (4%) | 5 | 6 |
| 4 | I | 101/108 (94%) | 71 (70%) | 19 (19%) | 11 (11%) | 1 | 0 |
| All | All | 1591/1624 (98%) | 1452 (91%) | 111 (7%) | 28 (2%) | 13 | 25 |

5 of 28 Ramachandran outliers are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 3 | A | 302 | LYS |
| 3 | A | 310 | ARG |
| 4 | B | 18 | LYS |
| 4 | B | 19 | ALA |
| 3 | F | 114 | LYS |

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 | |
|-----|-------|-----------------|------------|----------|-------------|----|
| 3 | A | 563/582 (97%) | 533 (95%) | 30 (5%) | 32 | 58 |
| 3 | F | 559/582 (96%) | 528 (94%) | 31 (6%) | 30 | 56 |
| 4 | B | 84/87 (97%) | 79 (94%) | 5 (6%) | 27 | 51 |
| 4 | I | 81/87 (93%) | 79 (98%) | 2 (2%) | 60 | 86 |
| All | All | 1287/1338 (96%) | 1219 (95%) | 68 (5%) | 32 | 58 |

5 of 68 residues with a non-rotameric sidechain are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 4 | B | 15 | ASP |
| 3 | F | 85 | ARG |
| 3 | F | 599 | ARG |
| 4 | B | 37 | MET |
| 4 | B | 80 | LEU |

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 32 such sidechains are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 3 | A | 667 | GLN |
| 3 | F | 123 | HIS |
| 3 | F | 667 | GLN |
| 4 | B | 83 | ASN |
| 3 | F | 173 | GLN |

5.3.3 RNA ⓘ

There are no RNA chains in this entry.

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

2 non-standard protein/DNA/RNA residues are 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 |
| 1 | 2DT | P | 822 | 1,2 | 18,20,21 | 0.92 | 1 (5%) | 20,28,31 | 1.41 | 2 (10%) |
| 1 | 2DT | X | 922 | 1,2 | 18,20,21 | 0.89 | 1 (5%) | 20,28,31 | 1.70 | 2 (10%) |

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 |
|-----|------|-------|-----|------|---------|-----------|---------|
| 1 | 2DT | P | 822 | 1,2 | - | 0/5/18/19 | 0/2/2/2 |
| 1 | 2DT | X | 922 | 1,2 | - | 0/5/18/19 | 0/2/2/2 |

All (2) bond length outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(Å) | Ideal(Å) |
|-----|-------|-----|------|-------|-------|-------------|----------|
| 1 | P | 822 | 2DT | C6-C5 | -2.38 | 1.33 | 1.40 |
| 1 | X | 922 | 2DT | C6-C5 | -2.30 | 1.33 | 1.40 |

All (4) bond angle outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(°) | Ideal(°) |
|-----|-------|-----|------|----------|-------|-------------|----------|
| 1 | X | 922 | 2DT | C6-N1-C2 | -5.24 | 120.92 | 122.41 |
| 1 | P | 822 | 2DT | C6-N1-C2 | -4.09 | 121.24 | 122.41 |
| 1 | X | 922 | 2DT | C5-C6-N1 | 2.52 | 124.04 | 121.59 |
| 1 | P | 822 | 2DT | C5-C6-N1 | 2.21 | 123.73 | 121.59 |

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5.5 Carbohydrates

There are no carbohydrates in this entry.

5.6 Ligand geometry

There are no ligands in this entry.

5.7 Other polymers

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 | P | 20/22 (90%) | -0.44 | 0 100 100 | 50, 100, 170, 171 | 0 |
| 1 | X | 21/22 (95%) | -0.31 | 0 100 100 | 49, 96, 198, 201 | 0 |
| 2 | T | 22/26 (84%) | -0.51 | 0 100 100 | 49, 90, 145, 153 | 0 |
| 2 | Z | 25/26 (96%) | -0.25 | 1 (4%) 36 32 | 49, 97, 183, 192 | 0 |
| 3 | A | 704/704 (100%) | -0.02 | 10 (1%) 72 72 | 38, 61, 116, 153 | 0 |
| 3 | F | 689/704 (97%) | -0.04 | 8 (1%) 75 77 | 38, 60, 105, 143 | 0 |
| 4 | B | 105/108 (97%) | 0.31 | 7 (6%) 17 15 | 50, 93, 113, 116 | 0 |
| 4 | I | 105/108 (97%) | 1.88 | 31 (29%) 1 1 | 51, 108, 147, 153 | 0 |
| All | All | 1691/1720 (98%) | 0.09 | 57 (3%) 43 39 | 38, 64, 135, 201 | 0 |

The worst 5 of 57 RSRZ outliers are listed below:

| Mol | Chain | Res | Type | RSRZ |
|-----|-------|-----|------|------|
| 4 | I | 16 | VAL | 17.7 |
| 4 | I | 84 | GLY | 11.5 |
| 4 | I | 53 | LEU | 11.1 |
| 4 | I | 83 | ASN | 9.6 |
| 4 | I | 87 | ALA | 9.5 |

6.2 Non-standard residues in protein, DNA, RNA chains 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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 | RSR | LLDF | B-factors(\AA^2) | Q<0.9 |
|-----|------|-------|-----|-------|------|-------|-----------------------------|-------|
| 1 | 2DT | P | 822 | 19/20 | 0.14 | -0.76 | 48,50,55,56 | 0 |
| 1 | 2DT | X | 922 | 19/20 | 0.14 | -0.93 | 48,52,57,59 | 0 |

6.3 Carbohydrates [i](#)

There are no carbohydrates in this entry.

6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.