



wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 1, 2016 – 02:05 AM GMT

PDB ID : 2FJ7
Title : Crystal structure of Nucleosome Core Particle Containing a Poly (dA.dT)
Sequence Element
Authors : Bao, Y.; White, C.L.; Luger, K.
Deposited on : 2005-12-31
Resolution : 3.20 Å(reported)

This is a wwPDB X-ray Structure 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/validation/2016/XrayValidationReportHelp>
with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467
Mogul : 1.7 (RC4), CSD as536be (2015)
Xtrriage (Phenix) : 1.9-1692
EDS : rb-20026688
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac : 5.8.0135
CCP4 : 6.5.0
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : trunk26865

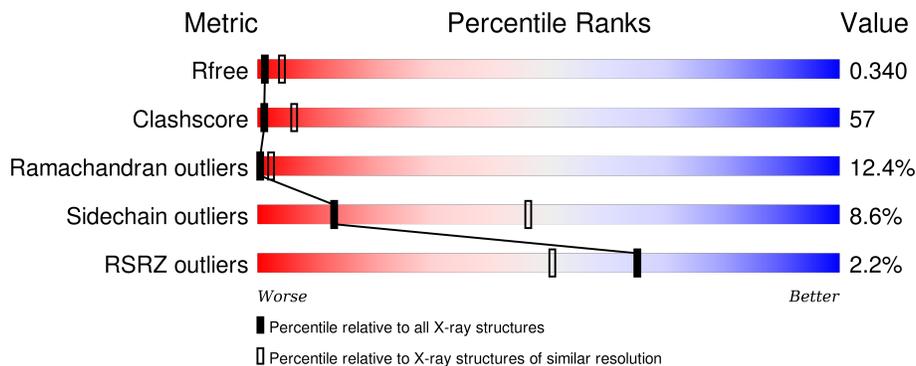
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.20 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} | 91344 | 1124 (3.24-3.16) |
| Clashscore | 102246 | 1024 (3.22-3.18) |
| Ramachandran outliers | 100387 | 1004 (3.22-3.18) |
| Sidechain outliers | 100360 | 1003 (3.22-3.18) |
| RSRZ outliers | 91569 | 1129 (3.24-3.16) |

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. 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 | I | 147 | |
| 2 | J | 147 | |
| 3 | A | 135 | |
| 3 | E | 135 | |
| 4 | B | 102 | |

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| Mol | Chain | Length | Quality of chain |
|-----|-------|--------|------------------|
| 4 | F | 102 | |
| 5 | C | 129 | |
| 5 | G | 129 | |
| 6 | D | 125 | |
| 6 | H | 125 | |

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 12038 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 DNA chain called 147 bp DNA containing 16 bp poly dA element.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|------|-----|-----|-----|---------|---------|-------|
| | | | Total | C | N | O | P | | | |
| 1 | I | 147 | 3013 | 1443 | 555 | 869 | 146 | 0 | 0 | 0 |

- Molecule 2 is a DNA chain called 147 bp DNA containing 16 bp poly dT element.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|------|-----|-----|-----|---------|---------|-------|
| | | | Total | C | N | O | P | | | |
| 2 | J | 147 | 3008 | 1445 | 526 | 891 | 146 | 0 | 0 | 0 |

- Molecule 3 is a protein called histone H3.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|-----|-----|-----|---|---------|---------|-------|
| | | | Total | C | N | O | S | | | |
| 3 | A | 98 | 808 | 509 | 156 | 140 | 3 | 0 | 0 | 0 |
| 3 | E | 98 | 808 | 509 | 156 | 140 | 3 | 0 | 0 | 0 |

- Molecule 4 is a protein called Histone H4.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|-----|-----|-----|---|---------|---------|-------|
| | | | Total | C | N | O | S | | | |
| 4 | B | 79 | 627 | 395 | 121 | 110 | 1 | 0 | 0 | 0 |
| 4 | F | 84 | 673 | 424 | 133 | 115 | 1 | 0 | 0 | 0 |

- Molecule 5 is a protein called histone H2A.

| Mol | Chain | Residues | Atoms | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|-----|-----|-----|---------|---------|-------|
| | | | Total | C | N | O | | | |
| 5 | C | 107 | 825 | 520 | 161 | 144 | 0 | 0 | 0 |
| 5 | G | 106 | 818 | 516 | 160 | 142 | 0 | 0 | 0 |

- Molecule 6 is a protein called Histone H2B.

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|-----|-------|----------|-------|-----|-----|-----|---|---------|---------|-------|
| | | | Total | C | N | O | S | | | |
| 6 | D | 93 | 729 | 459 | 131 | 137 | 2 | 0 | 0 | 0 |
| 6 | H | 93 | 729 | 459 | 131 | 137 | 2 | 0 | 0 | 0 |

There are 2 discrepancies between the modelled and reference sequences:

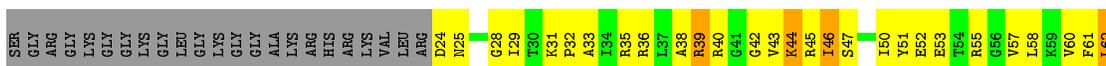
| Chain | Residue | Modelled | Actual | Comment | Reference |
|-------|---------|----------|--------|----------|------------|
| D | 29 | THR | SER | CONFLICT | UNP P02281 |
| H | 29 | THR | SER | CONFLICT | UNP P02281 |



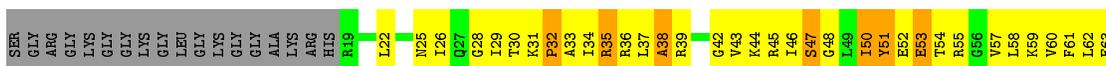
- Molecule 3: histone H3



- Molecule 4: Histone H4



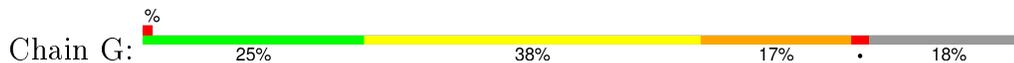
- Molecule 4: Histone H4



- Molecule 5: histone H2A

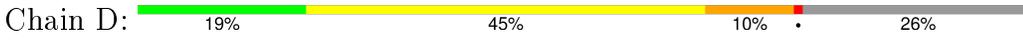


- Molecule 5: histone H2A

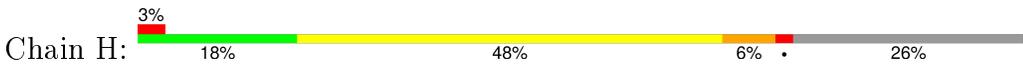




• Molecule 6: Histone H2B



• Molecule 6: Histone H2B



4 Data and refinement statistics

| Property | Value | Source |
|---|---|------------------|
| Space group | P 21 21 21 | Depositor |
| Cell constants a, b, c, α , β , γ | 104.92Å 109.60Å 177.97Å 90.00° 90.00° 90.00° | Depositor |
| Resolution (Å) | 50.00 – 3.20 37.89 – 2.69 | Depositor EDS |
| % Data completeness (in resolution range) | 95.2 (50.00-3.20) 78.9 (37.89-2.69) | Depositor EDS |
| R_{merge} | 0.07 | Depositor |
| R_{sym} | (Not available) | Depositor |
| $\langle I/\sigma(I) \rangle$ ¹ | 4.38 (at 2.69Å) | Xtriage |
| Refinement program | CNS | Depositor |
| R, R_{free} | 0.280 , 0.350 0.278 , 0.340 | Depositor DCC |
| R_{free} test set | 1653 reflections (5.03%) | DCC |
| Wilson B-factor (Å ²) | 71.7 | Xtriage |
| Anisotropy | 0.698 | Xtriage |
| Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²) | 0.26 , 81.7 | EDS |
| Estimated twinning fraction | 0.035 for k,h,-l | Xtriage |
| L-test for twinning ² | $\langle L \rangle = 0.45$, $\langle L^2 \rangle = 0.27$ | Xtriage |
| Outliers | 0 of 51523 reflections | Xtriage |
| F_o, F_c correlation | 0.92 | EDS |
| Total number of atoms | 12038 | wwPDB-VP |
| Average B, all atoms (Å ²) | 126.0 | wwPDB-VP |

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.55% 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, 0.375 respectively for untwinned datasets, and 0.333, 0.2 for perfectly twinned datasets.

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 | I | 0.35 | 0/3384 | 0.73 | 0/5220 |
| 2 | J | 0.40 | 0/3370 | 0.93 | 10/5201 (0.2%) |
| 3 | A | 0.44 | 0/820 | 0.81 | 1/1099 (0.1%) |
| 3 | E | 0.57 | 0/820 | 0.84 | 1/1099 (0.1%) |
| 4 | B | 0.49 | 0/634 | 0.76 | 0/848 |
| 4 | F | 0.58 | 0/680 | 0.87 | 0/908 |
| 5 | C | 0.53 | 0/835 | 0.83 | 2/1127 (0.2%) |
| 5 | G | 0.39 | 0/828 | 1.02 | 5/1117 (0.4%) |
| 6 | D | 0.56 | 0/740 | 0.78 | 0/994 |
| 6 | H | 0.44 | 0/740 | 0.66 | 0/994 |
| All | All | 0.44 | 0/12851 | 0.83 | 19/18607 (0.1%) |

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 |
|-----|-------|---------------------|---------------------|
| 2 | J | 0 | 2 |
| 5 | G | 0 | 2 |
| All | All | 0 | 4 |

There are no bond length outliers.

The worst 5 of 19 bond angle outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(°) | Ideal(°) |
|-----|-------|-----|------|-----------|--------|-------------|----------|
| 5 | G | 40 | ALA | O-C-N | -20.12 | 90.50 | 122.70 |
| 2 | J | 173 | DC | O5'-P-OP2 | -19.42 | 87.39 | 110.70 |
| 2 | J | 172 | DC | OP2-P-O3' | -17.76 | 66.12 | 105.20 |
| 2 | J | 172 | DC | OP1-P-O3' | -17.68 | 66.30 | 105.20 |
| 2 | J | 173 | DC | O5'-P-OP1 | -15.76 | 91.51 | 105.70 |

There are no chirality outliers.

All (4) planarity outliers are listed below:

| Mol | Chain | Res | Type | Group |
|-----|-------|-----|------|-------------------|
| 5 | G | 40 | ALA | Mainchain,Peptide |
| 2 | J | 231 | DT | Sidechain |
| 2 | J | 270 | DG | 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 | I | 3013 | 0 | 1661 | 243 | 0 |
| 2 | J | 3008 | 0 | 1672 | 248 | 0 |
| 3 | A | 808 | 0 | 846 | 179 | 0 |
| 3 | E | 808 | 0 | 846 | 139 | 0 |
| 4 | B | 627 | 0 | 663 | 109 | 0 |
| 4 | F | 673 | 0 | 722 | 113 | 0 |
| 5 | C | 825 | 0 | 884 | 134 | 0 |
| 5 | G | 818 | 0 | 877 | 132 | 0 |
| 6 | D | 729 | 0 | 753 | 119 | 0 |
| 6 | H | 729 | 0 | 753 | 96 | 0 |
| All | All | 12038 | 0 | 9677 | 1230 | 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 57.

The worst 5 of 1230 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) |
|-----------------|-----------------|--------------------------|-------------------|
| 4:B:45:ARG:O | 4:B:46:ILE:HG13 | 1.25 | 1.28 |
| 2:J:281:DA:H2'' | 2:J:282:DG:H5' | 1.25 | 1.15 |
| 3:E:61:LEU:HD12 | 4:F:37:LEU:HD23 | 1.28 | 1.15 |
| 3:A:117:VAL:HB | 4:B:44:LYS:HG2 | 1.23 | 1.14 |
| 5:G:26:PRO:HB2 | 5:G:29:ARG:HD2 | 1.32 | 1.12 |

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 | |
|-----|-------|---------------|-----------|-----------|----------|-------------|---|
| 3 | A | 96/135 (71%) | 55 (57%) | 25 (26%) | 16 (17%) | 0 | 1 |
| 3 | E | 96/135 (71%) | 61 (64%) | 21 (22%) | 14 (15%) | 0 | 1 |
| 4 | B | 77/102 (76%) | 45 (58%) | 25 (32%) | 7 (9%) | 1 | 5 |
| 4 | F | 82/102 (80%) | 57 (70%) | 19 (23%) | 6 (7%) | 1 | 9 |
| 5 | C | 105/129 (81%) | 73 (70%) | 20 (19%) | 12 (11%) | 0 | 3 |
| 5 | G | 104/129 (81%) | 64 (62%) | 21 (20%) | 19 (18%) | 0 | 0 |
| 6 | D | 91/125 (73%) | 59 (65%) | 23 (25%) | 9 (10%) | 1 | 4 |
| 6 | H | 91/125 (73%) | 56 (62%) | 26 (29%) | 9 (10%) | 1 | 4 |
| All | All | 742/982 (76%) | 470 (63%) | 180 (24%) | 92 (12%) | 0 | 2 |

5 of 92 Ramachandran outliers are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 3 | A | 45 | THR |
| 3 | A | 65 | LEU |
| 3 | A | 117 | VAL |
| 3 | A | 124 | ILE |
| 3 | A | 126 | LEU |

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 | |
|-----|-------|--------------|-----------|----------|-------------|----|
| 3 | A | 85/110 (77%) | 78 (92%) | 7 (8%) | 14 | 50 |

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| Mol | Chain | Analysed | Rotameric | Outliers | Percentiles | |
|-----|-------|---------------|-----------|----------|-------------|----|
| 3 | E | 85/110 (77%) | 77 (91%) | 8 (9%) | 11 | 41 |
| 4 | B | 64/78 (82%) | 60 (94%) | 4 (6%) | 22 | 63 |
| 4 | F | 69/78 (88%) | 66 (96%) | 3 (4%) | 35 | 75 |
| 5 | C | 85/101 (84%) | 76 (89%) | 9 (11%) | 8 | 34 |
| 5 | G | 84/101 (83%) | 76 (90%) | 8 (10%) | 11 | 40 |
| 6 | D | 79/105 (75%) | 72 (91%) | 7 (9%) | 12 | 44 |
| 6 | H | 79/105 (75%) | 71 (90%) | 8 (10%) | 9 | 36 |
| All | All | 630/788 (80%) | 576 (91%) | 54 (9%) | 13 | 46 |

5 of 54 residues with a non-rotameric sidechain are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 6 | D | 89 | ARG |
| 3 | E | 106 | ASP |
| 6 | H | 87 | THR |
| 6 | D | 93 | THR |
| 3 | E | 48 | LEU |

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 15 such sidechains are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 5 | C | 104 | GLN |
| 6 | D | 44 | GLN |
| 6 | H | 64 | ASN |
| 5 | C | 89 | ASN |
| 5 | G | 38 | 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 carbohydrates 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 [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 | I | 147/147 (100%) | -0.03 | 8 (5%) 29 17 | 77, 171, 203, 203 | 0 |
| 2 | J | 147/147 (100%) | -0.07 | 5 (3%) 49 34 | 82, 169, 203, 203 | 0 |
| 3 | A | 98/135 (72%) | -0.10 | 3 (3%) 52 38 | 41, 96, 171, 181 | 0 |
| 3 | E | 98/135 (72%) | -0.20 | 2 (2%) 68 54 | 21, 69, 145, 196 | 0 |
| 4 | B | 79/102 (77%) | -0.17 | 0 100 100 | 34, 87, 158, 192 | 0 |
| 4 | F | 84/102 (82%) | -0.35 | 0 100 100 | 24, 55, 103, 131 | 0 |
| 5 | C | 107/129 (82%) | -0.33 | 0 100 100 | 17, 62, 145, 184 | 0 |
| 5 | G | 106/129 (82%) | -0.19 | 1 (0%) 85 78 | 40, 95, 163, 201 | 0 |
| 6 | D | 93/125 (74%) | -0.27 | 0 100 100 | 25, 62, 118, 170 | 0 |
| 6 | H | 93/125 (74%) | -0.14 | 4 (4%) 39 25 | 25, 85, 164, 203 | 0 |
| All | All | 1052/1276 (82%) | -0.17 | 23 (2%) 65 50 | 17, 94, 200, 203 | 0 |

The worst 5 of 23 RSRZ outliers are listed below:

| Mol | Chain | Res | Type | RSRZ |
|-----|-------|-----|------|------|
| 3 | E | 135 | ALA | 5.5 |
| 1 | I | 147 | DT | 5.1 |
| 3 | E | 39 | HIS | 4.5 |
| 6 | H | 39 | TYR | 4.1 |
| 1 | I | 12 | DC | 3.5 |

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

There are no carbohydrates in this entry.

6.4 Ligands

There are no ligands in this entry.

6.5 Other polymers

There are no such residues in this entry.