Full wwPDB X-ray Structure Validation Report ⓘ

Aug 16, 2023 – 05:20 PM EDT

PDB ID	:	2AOH
Title	:	Crystal structure analysis of HIV-1 Protease mutant V82A with a substrate analog P6-PR
Authors	:	Tie, Y.; Boross, P.I.; Wang, Y.F.; Gaddis, L.; Liu, F.; Chen, X.; Tozser, J.; Harrison, R.W.; Weber, I.T.
Deposited on	:	2005-08-12
Resolution	:	1.42 Å(reported)

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

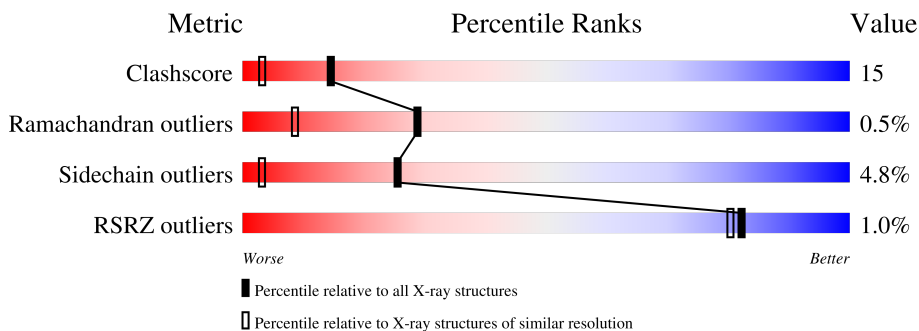|		
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.35
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35

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 1.42 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	Percentile Ranks	Value
Clashscore		15
Ramachandran outliers		0.5%
Sidechain outliers		4.8%
RSRZ outliers		1.0%

Worse — *Better*

▮ Percentile relative to all X-ray structures
⬚ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
Clashscore	141614	2696 (1.44-1.40)
Ramachandran outliers	138981	2632 (1.44-1.40)
Sidechain outliers	138945	2631 (1.44-1.40)
RSRZ outliers	127900	2528 (1.44-1.40)

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	99	77% 19% •
1	B	99	79% 19% •
2	C	10	20% / 10% 60% 20% 10%

2 Entry composition ⓘ

There are 5 unique types of molecules in this entry. The entry contains 1978 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 POL POLYPROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	99	Total	C	N	O	S	0	9	0
			789	513	137	136	3			
1	B	99	Total	C	N	O	S	0	9	0
			790	514	134	139	3			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	7	LYS	GLN	engineered mutation	UNP P04587
A	33	ILE	LEU	engineered mutation	UNP P04587
A	63	ILE	LEU	engineered mutation	UNP P04587
A	67	ALA	CYS	engineered mutation	UNP P04587
A	82	ALA	VAL	engineered mutation	UNP P04587
A	95	ALA	CYS	engineered mutation	UNP P04587
B	107	LYS	GLN	engineered mutation	UNP P04587
B	133	ILE	LEU	engineered mutation	UNP P04587
B	163	ILE	LEU	engineered mutation	UNP P04587
B	167	ALA	CYS	engineered mutation	UNP P04587
B	182	ALA	VAL	engineered mutation	UNP P04587
B	195	ALA	CYS	engineered mutation	UNP P04587

- Molecule 2 is a protein called PEPTIDE INHIBITOR.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	C	10	Total	C	N	O	0	10	0
			156	106	24	26			

- Molecule 3 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Na	0	0
			1	1		

• Molecule 4 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	2	Total 2	Cl 2	0	0

• Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	116	Total 116	O 116	0	0
5	B	115	Total 115	O 115	0	0
5	C	9	Total 9	O 9	0	0

3 Residue-property plots ⓘ

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: POL POLYPROTEIN

Chain A:

• Molecule 1: POL POLYPROTEIN

Chain B:

• Molecule 2: PEPTIDE INHIBITOR

Chain C:

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α, β, γ	58.88Å 86.28Å 46.40Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	10.00 – 1.42 34.80 – 1.42	Depositor EDS
% Data completeness (in resolution range)	90.3 (10.00-1.42) 84.5 (34.80-1.42)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.47 (at 1.42Å)	Xtriage
Refinement program	SHELXL-97	Depositor
R, R_{free}	0.179 , 0.233 0.166 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å^2)	13.0	Xtriage
Anisotropy	0.217	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.33 , 59.1	EDS
L-test for twinning [2]	$< |L| > = 0.50, < L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	1978	wwPDB-VP
Average B, all atoms (Å^2)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.72% of the height of the origin peak. No significant pseudotranslation is detected.*

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[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: CL, NA, FRD

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	0/839	1.27	4/1129 (0.4%)
1	B	0.56	0/840	1.26	6/1132 (0.5%)
2	C	0.58	0/136	1.33	0/180
All	All	0.55	0/1815	1.27	10/2441 (0.4%)

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	C	0	1

There are no bond length outliers.

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	57	ARG	CD-NE-CZ	10.90	138.86	123.60
1	B	150[A]	ILE	CA-C-N	9.88	135.95	116.20
1	B	150[B]	ILE	CA-C-N	9.88	135.95	116.20
1	A	8	ARG	NE-CZ-NH2	-9.47	115.57	120.30
1	B	141	ARG	NE-CZ-NH1	-7.01	116.80	120.30
1	B	129	ASP	CB-CG-OD2	-6.28	112.65	118.30
1	B	150[A]	ILE	CA-C-O	-6.16	107.16	120.10
1	B	150[B]	ILE	CA-C-O	-6.16	107.16	120.10
1	A	87	ARG	NE-CZ-NH1	5.65	123.12	120.30
1	A	65	GLU	OE1-CD-OE2	5.17	129.50	123.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	C	305[A]	FRD	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	789	0	850	21	0
1	B	790	0	842	24	0
2	C	156	0	151	22	0
3	A	1	0	0	0	0
4	B	2	0	0	0	0
5	A	116	0	0	8	0
5	B	115	0	0	14	0
5	C	9	0	0	8	0
All	All	1978	0	1843	56	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 15.

All (56) 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:46[A]:MET:HE1	5:A:1187:HOH:O	1.21	1.30
2:C:309[B]:THR:O	5:C:1194:HOH:O	1.59	1.19
2:C:303[B]:PHE:HZ	5:C:1240:HOH:O	1.38	1.07
1:A:46[A]:MET:CE	5:A:1187:HOH:O	1.82	1.02
1:B:163:ILE:HG23	1:B:170:LYS:HE3	1.45	0.97
1:A:50[A]:ILE:O	5:A:1103:HOH:O	1.84	0.95
1:B:147:ILE:HG22	2:C:302[B]:SER:OG	1.86	0.76
1:A:15:ILE:HD12	1:A:64[A]:ILE:HD11	1.67	0.74
1:A:7[A]:LYS:HD2	5:A:1130:HOH:O	1.89	0.70
1:A:21:GLU:HG2	5:A:1211:HOH:O	1.92	0.69
5:B:1083:HOH:O	2:C:305[B]:FRD:HE1	1.94	0.67
2:C:303[B]:PHE:CZ	5:C:1240:HOH:O	2.24	0.65
2:C:301[A]:VAL:HG12	5:C:1194:HOH:O	2.01	0.60
2:C:306[B]:PRO:HD2	5:C:1010:HOH:O	2.01	0.59
1:A:55:LYS:HE2	5:A:1117:HOH:O	2.05	0.56

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
5:B:1128:HOH:O	2:C:302[B]:SER:HA	2.04	0.56
1:A:15:ILE:HD12	1:A:64[A]:ILE:CD1	2.33	0.56
1:B:169:HIS:HE1	5:B:1179:HOH:O	1.90	0.54
1:B:149:GLY:HA2	2:C:305[B]:FRD:HE2	1.89	0.54
5:B:1151:HOH:O	2:C:308[B]:ILE:HG21	2.09	0.53
2:C:301[A]:VAL:HG23	5:C:1225:HOH:O	2.09	0.52
1:B:133[B]:ILE:HD12	1:B:136:MET:SD	2.50	0.52
1:B:169:HIS:HD2	5:B:1044:HOH:O	1.92	0.52
1:B:143[A]:LYS:HE2	5:B:1087:HOH:O	2.11	0.51
1:B:149:GLY:HA2	2:C:305[B]:FRD:CE2	2.42	0.49
2:C:302[B]:SER:HA	5:C:1160:HOH:O	2.12	0.49
1:B:145:LYS:HE3	2:C:309[A]:THR:OG1	2.13	0.48
1:A:41[B]:ARG:NH2	5:A:1239:HOH:O	2.45	0.48
1:B:107[A]:LYS:CG	5:B:1218:HOH:O	2.61	0.48
1:A:70[B]:LYS:HE2	1:A:71:ALA:O	2.13	0.48
1:A:14[B]:LYS:HG2	1:A:19:LEU:HD23	1.96	0.47
1:A:30:ASP:OD2	2:C:309[B]:THR:HG21	2.14	0.47
1:B:184:ILE:HD11	2:C:306[B]:PRO:HG3	1.95	0.47
1:B:107[A]:LYS:CD	5:B:1218:HOH:O	2.63	0.47
1:A:46[A]:MET:HE3	5:A:1187:HOH:O	1.78	0.46
1:B:130:ASP:OD2	2:C:302[B]:SER:HB2	2.15	0.46
2:C:307[B]:GLN:NE2	2:C:308[B]:ILE:O	2.50	0.45
1:B:118:GLN:HG3	5:B:1228:HOH:O	2.16	0.45
1:B:118:GLN:NE2	5:B:1081:HOH:O	2.50	0.45
2:C:301[A]:VAL:N	5:C:1129:HOH:O	2.50	0.45
1:A:28:ALA:HA	2:C:304[A]:ASN:HA	1.99	0.45
1:B:143[A]:LYS:NZ	5:B:1177:HOH:O	2.49	0.45
1:B:157:ARG:NH1	5:B:1137:HOH:O	2.50	0.44
1:A:99:PHE:OXT	1:B:101:PRO:N	2.50	0.44
1:B:142:TRP:CE2	1:B:157:ARG:HD2	2.52	0.44
1:A:64[B]:ILE:HG21	1:A:89:LEU:HD13	2.00	0.43
1:B:170:LYS:HD2	1:B:171:ALA:N	2.34	0.43
1:A:50[B]:ILE:O	1:B:150[B]:ILE:O	2.38	0.42
1:B:170:LYS:HD2	1:B:171:ALA:H	1.86	0.41
1:A:81:PRO:HG2	2:C:305[B]:FRD:HE2	2.03	0.40
1:B:107[A]:LYS:HD3	5:B:1218:HOH:O	2.21	0.40
1:A:64[A]:ILE:HG22	1:A:66:ILE:HG13	2.03	0.40
1:B:107[A]:LYS:HG2	5:B:1218:HOH:O	2.21	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	106/99 (107%)	106 (100%)	0	0	100	100
1	B	106/99 (107%)	104 (98%)	2 (2%)	0	100	100
2	C	14/10 (140%)	6 (43%)	6 (43%)	2 (14%)	0	0
All	All	226/208 (109%)	216 (96%)	8 (4%)	2 (1%)	29	3

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	C	302[A]	SER
2	C	302[B]	SER

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	88/80 (110%)	78 (89%)	10 (11%)	5	0
1	B	88/80 (110%)	86 (98%)	2 (2%)	50	17
2	C	16/8 (200%)	14 (88%)	2 (12%)	4	0
All	All	192/168 (114%)	178 (93%)	14 (7%)	25	1

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	7[A]	LYS

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Mol	Chain	Res	Type
1	A	7[B]	LYS
1	A	14[A]	LYS
1	A	14[B]	LYS
1	A	37[A]	SER
1	A	37[B]	SER
1	A	50[A]	ILE
1	A	50[B]	ILE
1	A	70[A]	LYS
1	A	70[B]	LYS
1	B	137	SER
1	B	170	LYS
2	C	301[A]	VAL
2	C	301[B]	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	2	GLN
1	A	98	ASN
1	B	118	GLN
1	B	169	HIS
1	B	198	ASN

5.3.3 RNA ⓘ

There are no RNA molecules 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	$\#|Z| > 2$
2	FRD	C	305[A]	2	10,10,10	0.66	0	10,12,12	1.06	1 (10%)
2	FRD	C	305[B]	2	10,10,10	0.45	0	10,12,12	0.51	0

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	FRD	C	305[A]	2	-	0/4/4/4	0/1/1/1
2	FRD	C	305[B]	2	-	0/4/4/4	0/1/1/1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	C	305[A]	FRD	C-CA-CB	-2.12	109.49	111.94

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	305[B]	FRD	4	0

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 3 ligands modelled in this entry, 3 are 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 ⓘ

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 ⓘ

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	99/99 (100%)	-0.49	0	100	100	11, 18, 30, 32	1 (1%)
1	B	99/99 (100%)	-0.56	0	100	100	10, 17, 29, 33	0
2	C	9/10 (90%)	0.85	2 (22%)	0	0	13, 18, 30, 30	0
All	All	207/208 (99%)	-0.46	2 (0%)	82	80	10, 17, 30, 33	1 (0%)

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	C	301[A]	VAL	3.1
2	C	310[A]	ALA	2.9

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

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	FRD	C	305[A]	10/10	0.97	0.10	12,14,17,17	10
2	FRD	C	305[B]	10/10	0.97	0.10	14,16,18,18	10

6.3 Carbohydrates ⓘ

There are no monosaccharides in this entry.

WORLDWIDE
wwPDB
PROTEIN DATA BANK

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
3	NA	A	500	1/1	0.98	0.16	30,30,30,30	0
4	CL	B	501	1/1	0.99	0.04	22,22,22,22	0
4	CL	B	502	1/1	1.00	0.17	9,9,9,9	1

6.5 Other polymers (i)

There are no such residues in this entry.

W O R L D W I D E

PDB

PROTEIN DATA BANK