The worldwide Protein Data Bank (wwPDB): ensuring a single, uniform archive of PDB data

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ABSTRACT

The worldwide Protein Data Bank (wwPDB) is the international collaboration that manages the deposition, processing and distribution of the PDB archive. The online PDB archive is a repository for the coordinates and related information for more than 38,000 structures, including proteins, nucleic acids and large macromolecular complexes that have been determined using X-ray crystallography, NMR and electron microscopy techniques. The founding members of the wwPDB are RCSB PDB (USA), MSD-EBI (Europe) and PDBj (Japan) [H.M. Berman, K. Henrick and H. Nakamura (2003) Nature Struct. Biol., 10, 980]. The BMRB group (USA) joined the wwPDB in 2006. The mission of the wwPDB is to maintain a single archive of macromolecular structural data that are freely and publicly available to the global community. Additionally, the wwPDB provides a variety of services to a broad community of users. The wwPDB website at http://www.wwpdb.org/ provides information about services provided by the individual member organizations and about projects undertaken by the wwPDB.

HISTORY AND BACKGROUND

The Protein Data Bank (PDB) was founded in 1971 to provide a repository for three-dimensional (3D) structure data of experimentally determined biological macromolecules (1–3). The PDB archive contains 3D coordinate data, information about the chemical content such as polymer sequence and ligand chemistry, information about the experiment used to derive the structure and some qualitative descriptions of the structure. When the PDB was in its infancy, the archive contained seven structures composed of loosely structured free text. Today, the PDB archive contains close to 40,000 structures and relies upon strict ontologies that define the content of these entries.

The data contained in the PDB are generated and submitted by scientists from around the globe to sites in the United States, Europe and Asia. The worldwide PDB (wwPDB) was established in 2003 to formally recognize the international nature of the PDB archive (2,4) and to ensure that the data files remain uniform in content and format. The founding members are the RCSB PDB (USA) (1), the Macromolecular Structure Database at the European Bioinformatics Institute (MSD-EBI) (5) and the Protein Data Bank Japan (PDBj) at Osaka University. These wwPDB sites share responsibilities in data deposition, processing and distribution of the PDB archive, and agree to support a single, standardized archive of structural data (Table 1). The BioMagResBank (BMRB) at the University of Wisconsin-Madison (USA) (6) became a member in 2006 and will be a deposition site for primary experimental data and PDB data.

A wwPDB Advisory Committee (wwPDBAC) consists of representatives appointed by each member site as well as representatives of the international X-ray, NMR and electron microscopy (EM) communities. wwPDBAC meets yearly and provides advice about policies governing the content, format and distribution of the PDB data files.

The website (http://www.wwpdb.org/) contains the formal agreement for the operation of the wwPDB organization, links to the deposition and access sites, and news and announcements about policies and projects related to the wwPDB.

MEMBER DEPOSITION SITES

The advances in protein cloning, expression, labeling, purification through to structure determination has resulted in a rapid increase in the rate at which new protein structures are determined. Progress is also being made in structure determinations of nucleic acids, particularly RNA molecules. A key component of the wwPDB is that its tools are able to efficiently capture and curate data as the amount deposited
The PDB archive is the collection of flat files that are maintained in three different formats: the legacy PDB file format; the PDB exchange format that follows the mmCIF syntax (http://deposit.pdb.org/mmcif/); and the PDBML/XML format; the PDB exchange format that follows the mmCIF syntax (http://deposit.pdb.org/mmcif/). The PDB archive is updated weekly.

The ‘PDB archive’ is the collection of flat files that are maintained in three different formats: the legacy PDB file format; the PDB exchange format that follows the mmCIF syntax (http://deposit.pdb.org/mmcif/); and the PDBML/XML format (7) that is a direct translation of the PDB exchange format for data capture and processing (ADIT, ADIT-NMR and AutoDep), all the data are annotated and processed using common standards.

wwPDB members collaborate to ensure the uniformity of the PDB archive. The PDB Exchange Dictionary consolidates content from a variety of dictionaries and includes extensions to describe NMR, EM and protein production data (15). wwPDB data processing, exchange and annotation depend upon this dictionary and the mmCIF format (16) to help make the data more consistent across the archive.

In the past, query across the complete PDB archive has been limited by missing, erroneous and inconsistently reported data, nomenclature and functional annotation. The evolution of experimental methods, functional knowledge of proteins and methods used to process these data has introduced various inconsistencies into the PDB archive and has inspired different versions of the PDB format.

Over the years, the MSD-EBI, PDBj and the RCSB PDB have been working individually on correcting errors in the archive. Under the wwPDB banner, these groups are now working to integrate all remediation efforts into a single consistent collection of data files. This work includes improving the representation of PDB small molecule data, assessing the required chemical definitions and their correspondences in PDB entries, resolving any remaining differences in the representation of PDB small molecule data, assessing the required chemical definitions and their correspondences in PDB entries, resolving any remaining differences in the macromolecular sequences assigned by each group and resolving differences in primary citation assignments. The BMRB has been collaborating with MSD-EBI and RCSB PDB on standardizing restraint data associated with PDB depositions (17,18).

The remediated data (PDB V.2) will be made available for public review in 2007 and will form the basis of the wwPDB websites. The data released before remediation (PDB V.1) will continue to be available for the historical record.

### Table 1. wwPDB Data deposition and access sites

| Access PDB FTP           | Deposit data               | Main website                              |
|--------------------------|----------------------------|-------------------------------------------|
| RCSB PDB ftp://ftp.rcsb.org/pub/pdb | http://deposit.rcsb.org | http://www.pdb.org                        |
| MSD-EBI ftp://ftp.ebi.ac.uk/pub/databases/rcsb/pdb | http://www.ebi.ac.uk/msd-srv/autodep4 | http://www.ebi.ac.uk/msd                     |
| PDBj ftp://pdb.protein.osaka-u.ac.jp/pub/pdb | http://www.pdbj.org/deposit.html | http://www.pdbj.org                         |
| BMRB http://batfish.bmrb.wisc.edu/bmrb-adit | http://batfish.bmrb.wisc.edu | http://www.bmrb.wisc.edu                    |

### Table 2. PDB structures deposited and processed by year and site (as of August 28, 2006)

| Year | Total depositions | Deposited to RCSB PDB | Deposited to PDBj | Deposited to EBI | Processed by RCSB PDB | Processed by PDBj | Processed by EBI |
|------|-------------------|-----------------------|-------------------|------------------|-----------------------|-------------------|------------------|
| 2000 | 2983              | 2445                  | 10                | 528              | 2294                  | 161              | 528              |
| 2001 | 3286              | 2673                  | 118               | 495              | 2407                  | 384              | 495              |
| 2002 | 3563              | 2769                  | 289               | 505              | 2401                  | 167              | 505              |
| 2003 | 4830              | 3488                  | 673               | 669              | 3135                  | 1026             | 669              |
| 2004 | 5508              | 3796                  | 900               | 812              | 3083                  | 1613             | 812              |
| 2005 | 6677              | 4506                  | 1166              | 1005             | 3562                  | 2110             | 1005             |
| 2006 | 4728              | 3239                  | 725               | 764              | 2639                  | 1305             | 764              |
| Total| 31 575            | 22 916                | 3881              | 4778             | 19 545                 | 7252             | 4778             |

### Table 3. PDB structures released per year (experimentally solved structures only, as of August 28, 2006)

| Year | Total |
|------|-------|
| 2000 | 2632  |
| 2001 | 2840  |
| 2002 | 3018  |
| 2003 | 4185  |
| 2004 | 5230  |
| 2005 | 5421  |
| 2006 | 4154  |
| Total| 27 480|

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In addition to providing access to the PDB archive, each wwPDB site provides databases and websites that provide different views and analyses of the structural data contained within the PDB archive (8–14).
PHASING OUT THEORETICAL MODEL DEPOSITIONS TO THE PDB ARCHIVE

Effective October 15, 2006, PDB depositions were restricted to atomic coordinates that are substantially determined by experimental measurements on specimens containing biological macromolecules. This policy was recommended and endorsed by a working group composed of structural and computational biologists and endorsed by the wwPDB Advisory Committee. Thus, theoretical model depositions (such as models determined purely in silico using, for example, homology or ab initio methods) will no longer be accepted.

NEWS AND ANNOUNCEMENTS

The News sections of the wwPDB website gives information about the outcome of the wwPDBAC meetings and policy statements affecting the PDB data files. A recent example is the announcement of the policy for the archiving of in silico models (19).

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Conflict of interest statement. None declared.

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