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Structural view of biology: Exploring new perspectives for deeper learning

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Rapid expansion in the content knowledge of biology presents a challenge for educators and students alike. Understanding "Structure and Function" has been identified as a core concept in biology1. In fact, uncovering the relationship between three dimensional (3D) structure and function has paved the way for many major discoveries and technical advances in biology and medicine. Modeling and simulation together with data from large databases is considered a core competency in teaching and learning biology. Several biology databases provide free access to different information about biological molecules such as proteins, nucleic acids, and various interacting small molecules. The challenge in effectively using these data resources for education involves (a) knowledge about them and the data that they provide, and (b) curricula that can help students meaningfully explore these resources to learn about a specific theme or topic of interest. Both these aspects will be discussed herein.

Protein Data Bank (PDB), the single global repository of biomolecular structures, archives and provides free access to more than 127,000, experimentally determined 3D structures of biological macromolecules and their complexes. The PDB archive is managed by the Worldwide Protein Data Bank partnership (wwPDB, wwpdb.org), which includes the RCSB Protein Data Bank (rcsb.org), the Protein Data Bank in Europe (PDBe, pdbe.org), the Protein Data Bank Japan (PDBj, pdbj.org), and BioMagResBank (BMRB, bmrb.org).

The Research Collaboratory for Structural Bioinformatics Protein Data Bank2,3 (RCSB PDB; www.rcsb.org) provides free access to PDB data and is an essential bio-molecular data resource that supports scientific research and education worldwide. Along with tools/resources for visualizing and analyzing PDB data, the RCSB PDB also presents links to other related biological data resources that provide relevant information about these molecules for understanding their functions in biology and medicine. A dedicated education and outreach portal (PDB-101; pdb101.rcsb.org/) was developed for students and educators to access a simplified view of PDB data.

In the past decade, RCSB PDB faculty have developed and offered courses, curricula, and workshops for students and educators at different levels - high school to undergraduate and graduate levels. Curricula have focused on topics ranging from protein crystallography methodology to structural views of specific topics in biology and medicine. A guiding principle in designing these curricula is integrating information from a variety of biological databases, and training students to access, interpret and use these varied information to generate new knowledge. Most of these curricula are developed and/or taught collaboratively. This ensures that the presented material meet the needs of its target audience and provide multidisciplinary perspectives. Examples of the curriculum development, educational experiences, and resources will be presented.

[1] AAAS (2011) "Vision and Change in Undergraduate Biology Education: A Call to Action." Washington, DC, http://visionandchange.org/
[2] Berman, H. M., et al., (2000). Nucleic Acids Research 28 (1): 235-242.
[3] Zardecki, C., et al., (2016). Journal of Chemical Education 93(3): 569-575.

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