Process of Science
Explore the Budding Biologist in You

Two of the most important aspects of doing biology as a science are, 1) the ability to model complex processes and molecules, and 2) communicating research findings to the scientific and general audiences. As we see in this month's Feature and Public Eye articles, biological processes occur on scales and timetables that strain our imagination. Our ability to comprehend these events, however, is critical to both understanding biology and developing research questions that forward our knowledge in the discipline. Once data is obtained in the lab, the results need to be communicated and accepted within the scientific community. This month in the **Process of Science**, *BioWeb* investigates two websites that help young investigators like you gain proficiency in these critical aspects of a career in professional science. Although you may be away from the university and its laboratory facilities for the summer, you still have your computer and your scientific curiosity! So, this month's topic is not an experiment perse, it is instead an opportunity for you to grow as a scientist.

One of the most perplexing challenges to biologists is to understand the structure and function of biomolecules. Too tiny to see, these structures are at the heart of most biological processes. Recent innovations in the science of structural biology have made it possible to model these structures using computer technology. These molecular animations can be revealed in a number of formats that help students and scientists understand just what the heck they look like. From 3-D protein molecules to cell membranes, these digital recreations shed light into the function of biology at the molecular level.

One new website that has brought thousands of these

images together for study is the Image Library of Biological Macromolecules. Featured in such prestigious science journals as *Nature, Science,* and *Trends in Ecology and Evolution,* this site has received praise for providing extraordinary molecular image resources to professional scientists and students alike. Developed by the Institute for Molecular Biotechnology in Jena, Germany, the Image Library allows users to model individual molecules in a variety of formats. For example, you could investigate the structures of molecules that are discussed in this month's articles. Thousands of proteins and nucleic acids (DNA, RNA, etc.) are available in ribbon and stick forms and in space-filling models. From these models, you can see their ultrastructure and better understand their chemical properties. (It is the inherent properties of proteins that make them such good candidates for forensic analysis.)

A particularly noteworthy section of the site is the "Molecules of Life." Here, the molecular forms become a provocative nexus of science and art. And the site's functionality allows you to manipulate the forms; zoom in, then out, and turn them around. They are hauntingly beautiful images. A particularly informative section is the "Experimental Determination of Bipolymer Molecules." Here, the various techniques of uncovering the structures of molecules are discussed; from X-ray crystallography to Nuclear Magnetic Resonance Imaging. The site also includes profiles of five Nobel Prize-winning projects in structural biology that feature the molecules discovered, as well as engaging histories of the research scientists. Included in this group are James Watson and Francis Crick, biologists at Cambridge University who were awarded Nobel Prizes in 1962 for discovering DNA, and whose work on elucidating the structure of DNA is chronicled.

Equally important to doing good science in the lab is bringing the findings to light by way of publications. The process of science is centered on the ideas of peer review and public scrutiny. Publishing in scientific journals is one of the core activities of productive research biologists and is critical to any scientist's career. Undergraduate students too often have very little opportunity to participate in the publishing process and arrive in graduate school unprepared for that aspect of science. Although some schools have

in-house publications or mini-conferences for undergraduates, the research findings rarely leave the campus. There is good news out there for talented and motivated undergraduates interested in publishing their research findings. A website has been established with the support of the National Science Foundation called the National Undergraduate Research Clearinghouse. This site provides information on at least a half dozen new undergraduate journals, with details how on how students can publish their work.

One of the most interesting journals is a joint publication of Duke University and Swarthmore College entitled the National Journal of Young Investigators (JYI). Undergraduate students conduct all the work featured. Each article is reviewed by faculty and students. JYI is multidisciplinary but devoted to the natural sciences and engineering. The articles are wide-ranging in scope. The latest issue features articles on such topics as bird behavior and chemical self-assembly of macromolecules. As a student, you can review these articles for both content and style. Look carefully at the organization and especially the economy of style. There are no wasted words in journal articles!

Both of these websites can be valuable tools as you prepare for your next year at college. While looking at the journal articles, think about what research topics interest you and how you might fashion a question for your own work. An independent undergraduate research project and senior thesis are invaluable experiences to have as you enter graduate school or the workplace. Understanding the ultrastrucure of biomolecules will help you in every biology course you take. Understanding the nature of scientific publishing will help you become a better scientist. Happy surfing!

Resources and Websites

Image Library of Biological Molecules

National Journal of Young Investigators

National Undergraduate Research Clearinghouse

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