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## ***The Need to Change the Way We Teach the Sciences***

Over the past 15-20 years people have been talking about putting a flavor of research into the undergraduate science curriculum. Prompted first by Project Kaleidoscope, and more recently by publications from HHMI and the National Academies of Science, there has been a quiet revolution in the way that science is being taught in some classrooms and could be taught in virtually any classroom. Some faculty are incorporating their own research into the classroom, whether lecture or laboratory, and to good effect. These efforts are being supported by several of the major funding agencies, most notably the National Science Foundation and the Howard Hughes Medical Institute, and increasing evidence suggests that it is working. Students, whether they are science majors or not are getting exposed to the excitement of research and seeing science in a modern context, not simply as a series of “facts and equations (though unfortunately too frequently the equations are left out!)” that have to be memorized and used formulaically. The molecular life sciences are dynamic (even chemistry and physics when not taught from a historical perspective are also filled with interesting application oriented facets that excite students) and should be presented that way. Students at any level must be shown the forefronts of the challenges that are being addressed by science so that they can appreciate why the fundamental principles are so unifying and important to understand. We can no longer afford to teach “chemistry” or “physics” or “biology,” we must teach students! The best way to teach students is to engage and excite them about the subjects, and there is no better way than to introduce research into the curriculum. Their ability to engage in some aspect of the research process from the very start of their undergraduate

education (and even earlier) fosters their learning and creates a “mentoring” relationship that helps direct their undergraduate career and future choices. Students that connect with faculty early in their undergraduate careers are more likely to stay with a program, be better adjusted to college life, and in general be happier and hence more productive. College is a big adjustment for many students, and introductory science classes that approach things as a mere extension of high school (if we don’t teach them like they are in high school they won’t learn anything is a common comment) are fostering the wrong environment and, simply put, making matters worse (if we teach them the basics thoroughly we can teach them the exciting stuff later once they are science majors is again the common mantra of advocates of the more “traditional” approaches to teaching 1st year students). Faculty that advocate such approaches simply just don’t get it. If we don’t *a*) challenge students to learn, and *b*) excite them about the sciences they will simply become business majors because they can see the point and rewards of that.

There are many components to both the problem and the answers that must be addressed, and it will take courage on the part of all concerned to revitalize the teaching of science on a global level. Universities and Colleges, departments and programs, and chairs and administrators must first appreciate the critical nature of the problem and be willing to recognize that there are different ways of solving the problems that face science education. The one thing that is clear is that continuing what we have been doing is not the answer. Of course if it were we wouldn’t be facing the near crisis that we are facing in science. In the past year or two many, including myself, have written about parts of the problem

and parts of the solution, but as life scientists we must recognize the whole problem and see that the solutions must be linked..

To reiterate in part what I wrote several years ago, and to amplify on what others have been saying since, I think the problem can be broken down into three parts: who we teach, what we teach, and how we teach, and during the coming year ASBMB Today and Enzymatic will feature a series of editorials and articles from scientists and educators around the nation and the world (these issues are not unique to the USA but certainly finding the answers is perhaps more critical to this country at this

point in time) addressing these issues and discussing potential approaches to solutions.

Three symposia at this year's ASBMB Annual Meeting (the Centennial Meeting) will focus on parts of the problem and the potential solutions and hopefully will help generate the substantive discussions that need to take place to find the answers.

If you have an opinion on these issues or suggestions for novel approaches to solutions please let us know.

### ***A New Year, a New Focus:***

“Enzymatic” continues to evolve, having made the transition to an eNewsletter this year. It will link more closely with both ASBMB Today and with the Education and Professional Development web pages to serve both the society membership and the education community. Several new regular features that will be found in Enzymatic are featured in this issue: ***JBC in the Classroom***, which features papers from the Society's flagship scientific publication that are used in the classroom, and ***Quantitative Problem Sets***, which feature quantitative data from various courses around the country that can be used in the classroom.

### ***ASBMB AWARD FOR EXEMPLARY CONTRIBUTIONS TO EDUCATION***

In 2005 the Society created a new award, which is administered by the ASBMB Education and Professional Development Committee.

The Award is given annually to a scientist who encourages effective teaching and learning of biochemistry and molecular biology through his/her own teaching, leadership in education, writing, educational research, mentoring, or public enlightenment.

The Award consists of a cash prize of \$3,000, and the winner will present a plenary symposium lecture at the next Society Meeting.

The first award winner is Tom Cech, President of HHMI, who will receive the inaugural award and present a plenary talk on Sunday April 2<sup>nd</sup> at the San Francisco meeting titled “Always a Teacher, Always a Student.” [In a recent issue of ASBMB Today the award to Dr. Cech was highlighted.](#)

It is time to nominate educators for the 2007 Award. Details of the nomination process can be found at: <http://www.asbmb.org>

## ***XΩA***

### ***The Biochemistry & Molecular Biology Undergraduate Honor Society***

The American Society for Biochemistry and Molecular Biology is pleased to introduce ***XΩA, the Biochemistry & Molecular Biology Honor Society***, for outstanding undergraduate students pursuing a degree in the molecular life sciences at a college or university that is a member of the Undergraduate Affiliates Network (UAN). Member institutions automatically qualify to create a local chapter of the ***XΩA, the Biochemistry & Molecular Biology Honor Society***, and local chapters may nominate eligible students for election to ***XΩA***. Upon election students will receive a certificate of membership, an ASBMB Travel Award to the next ASBMB Meeting, and the ***XΩA*** lapel pin.

#### ***Who may nominate students?***

Faculty advisors of UAN Chapters may nominate up to 2 junior and 2 senior students per year for election to the national chapter of ***XΩA, the Biochemistry & Molecular Biology Honor Society***.

#### ***Nomination materials should include:***

- 1. A letter of nomination.***
- 2. An unofficial transcript indicating science courses taken and gpa.***
- 3. A 1-page CV of the student indicating presentations made at scientific meetings, publications, and outreach activities the student has engaged in.***
- 4. Letters of support---no more than three letters of support may be submitted.***
- 5. A copy of an abstract submitted for the next ASBMB National Meeting.***

***All materials should be received by February 28<sup>th</sup>. Students elected to the national chapter of XΩA, the Biochemistry & Molecular Biology Honor Society, will be notified by March 15<sup>th</sup>.***

#### ***Are You Going to San Francisco?***

The San Francisco ASBMB Meeting will be something different. From the opening day focus on the future, with undergraduate science being highlighted with the 10<sup>th</sup> Poster Competition, the meeting has something for everyone.

This year the undergraduate poster competition will be on the opening day of the meeting, and immediately after the competition there will be a plenary lecture for undergraduates by Ed Krebs and Eddie Fischer. The lecture will be followed by the opening plenary where Society President Judith Bond will introduce the winners of the Undergraduate Poster Competition as well as the various Nobel Laureates who illustrate the rich history of ASBMB. If you are planning a "Landmarks" Seminar (see

the previous issue of “Enzymatic”) be sure to let your regional UAN Director know now so that the appropriate arrangements can be made for the San Francisco Meeting. To qualify for the student and faculty travel awards associated with the “Landmark” Seminars, students need to submit an abstract for the meeting to present their research at the Poster Competition, and faculty should submit an abstract for the Education Posters .

### ***Program Reunions***

Several Undergraduate Programs are planning alumni reunions for the San Francisco meeting, and we would like to hear about any such plans and help publicize such events. Please contact ASBMB and let us know your reunion plans.

### ***Letting Students Learn***

In recent years it has become more accepted that student research plays a critical role in the learning process: anecdotally, students that engage in research are more likely to go on in science and more likely to do better in courses that are traditionally regarded as “difficult.” They are more inclined to take courses regarded as difficult once they have gotten established in a research project. What is it about the research enterprise that fosters this, and how can it be adapted to a standard classroom setting to further student learning?

Clearly part of the answer lies in the motivation that comes from investigating the unknown: attempting to answer questions and find information that is not known to either the student or the research mentor is exciting. However I would like to make an argument that a major factor lies elsewhere, and it is a factor that can easily be applied to any classroom setting. What characterizes research is the ability to think, to hypothesize, to construct an experiment, and to think about possible outcomes and their interpretations. These take time, and often time to think is what is lacking in the traditional classroom. As teachers we become too enamoured with teaching students facts and what they mean rather than a process that will let the student become better educated and able to teach themselves. If we don’t fill every moment of classroom time with this “teaching” some feel we are not doing our job!

This is not how research works. In research there is time to talk, to think, to kick around ideas until you find the right approach, to let things sink in, time to formulate the right questions and to seek answers: maybe this is what students find so attractive about research---they learn how to think and find out answers for themselves. A research mentor takes the time to allow students to develop their own approaches and ideas and as a result the student learns more, understands more, and puts the pieces together in a more coherent fashion.

These approaches can easily be adapted to the classroom: if we are prepared to give up a little time. Critics argue that this means giving up content, but I disagree. There are many parts of the “content” of most courses that students are quite capable of “learning” on their own. The classroom for part, at least, of the typical class period should be a site of “active learning” (for example as discussed in the previous issue of Enzymatic in “Guide on the Side” by Joe Bobich from TCU).

## Inside the Education and Professional Development Committee

The Education and Professional Development (EPD) Committee of the American Society for Biochemistry and Molecular Biology represents the interests of members of the Society in the arena of education and outreach as well as professional development. The committee, whose members are appointed by the President of the Society, organizes the “Education and Professional Development” theme meeting at the National Meeting each year and serves the membership of the Society through the Education and Professional Development web site accessible through the Society’s web page. The committee also administers the Society’s Undergraduate Affiliates Network (UAN) and has recently established a separate UAN Steering Committee, composed of the regional directors of the UAN, that nominates two EPD committee members to ensure close collaboration between the activities of the two committees. The UAN Steering Committee will administer undergraduate student and faculty travel awards and the newly formed *ΧΩΔΒιοchemistry & Molecular Biology Honor Society* (see article in this issue for details). The UAN Steering Committee will meet at the National Meeting each year whereas the Education and Professional Development Committee holds a fall retreat each year.

Although the UAN Steering Committee has a defined mandate for undergraduate education, the Education and Professional Development Committee has members from all walks of the profession and at all stages of career development, from graduate and postdoctoral fellow representatives to faculty from diverse types of institutions to industry representatives. The three major funding agencies associated with Biochemistry and Molecular Biology (NIH, HHMI, and NSF) are also represented in the committee membership.

### *Focus on Faculty:*

#### Brad Wallar and the new Undergraduate Affiliate at Grand Valley State University



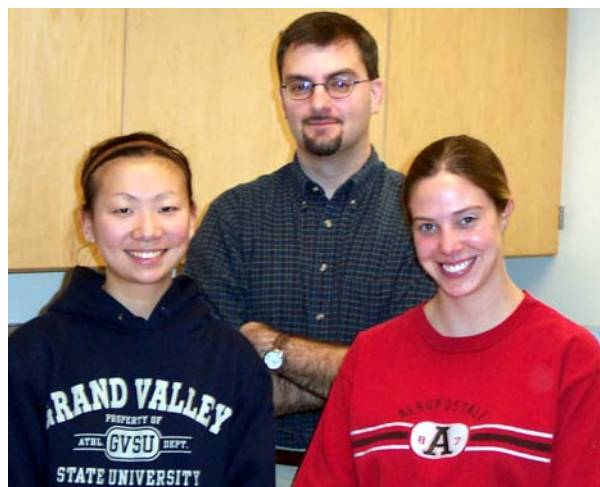
In his 3rd year at Grand Valley State University (GVSU), Dr. Brad Wallar is already well aware of the impact that undergraduate training can have on a student’s career. After 4 semesters, he has taught more than 400 students in undergraduate biochemistry and molecular biology courses and currently has 4 students in his research laboratory. In addition, GVSU has joined the Undergraduate Affiliates Network (UAN) of the ASBMB with more than 45 new undergraduate student members (<http://www2.gvsu.edu/~bmbclub>).

Grand Valley State University is a comprehensive university that is located in Allendale, Michigan. Although the largest campus is in Allendale, GVSU

has four other campuses throughout the state of Michigan. The current enrollment of more than 22,000 students has the opportunity to be involved in over 100 academic and career preparation programs leading to degrees in more than 75 major areas. The mission of GVSU focuses on excellence in teaching and active scholarship. Although Michigan residents are the predominant group in the student population, GVSU is one of the most rapidly growing universities in the nation and has continued to expand the composition of the incoming students to reflect that of the entire Midwest and beyond.

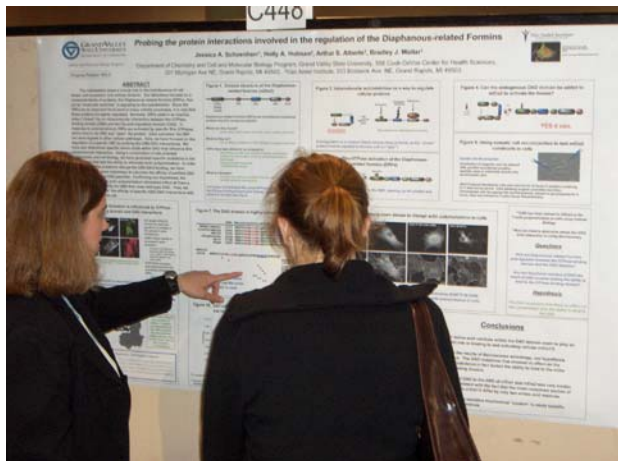
Dr. Wallar is an assistant professor in the chemistry department at GVSU (<http://www.gvsu.edu/chem>), which includes over 120 student majors. The 25 tenure track professors, with the help of affiliate faculty members, teach more than 3000 students enrolled in chemistry courses each semester. In addition to the strong dedication to teaching excellence, the faculty maintain active research with undergraduate students in their diverse fields. Dr. Wallar is also a member of the Cell and Molecular Biology Program ([http://www.gvsu.edu/cm\\_biology](http://www.gvsu.edu/cm_biology)), which is a group of 30 faculty representing the Departments of Biology, Biomedical Health Sciences, and Chemistry. With laboratories at the Allendale campus and the new Cook-DeVos Center for Health Sciences building in downtown Grand Rapids, the Cell and Molecular Biology faculty mentor undergraduate students conducting research ranging from plant biology to cell signaling to peptide chemistry.

Originally from Montrose, Michigan, Dr. Wallar earned a B.S. degree in Biology at the University of Michigan-Flint in 1993. While at UM-Flint, he had the opportunity to perform 2 years of biochemical research with a member of the chemistry Department, as well as serve as a teaching assistant in both chemistry and biology classes. The idea that he would become an undergraduate mentor in the future resulted from the excellent teaching and research experiences at UM-Flint. In December of 2000, he then received a Ph.D. in Biochemistry, Biophysics, and Molecular Biology at the University of Minnesota. His doctoral work in John Lipscomb's laboratory involved a broad spectrum of research, including enzyme kinetics, protein biochemistry, spectroscopy, and molecular biology. For the next 2½ years, he then "switched gears" and performed postdoctoral research in Art Alberts' Laboratory of Cell Structure and Signal Integration at the Van Andel Institute (VAI) in Grand Rapids, Michigan.



After moving to Grand Valley State University, Dr. Wallar has maintained a research collaboration with Art Alberts' group at VAI in the study of a conserved family of proteins called the diaphanous-related formins (DRFs). DRFs act as "molecular switches" to signal the cytoskeleton and have been implicated in the maintenance of cell shape, the ability of cells to move, and cellular division. Because the DRFs are an important focal point for so many cellular processes, it is vital that these proteins are tightly regulated and only activated in response to a cellular signal, as uncontrolled DRFs can result in dire consequences for a cell. Like many other cellular proteins, until they are stimulated by a specific

cellular signal, DRFs remain in an inactive state. This natural tendency to stay in an inactive state is mediated by specific binding between domains at their N and C termini. Dr. Wallar's research laboratory focuses on this "autoregulation" of the DRF by studying the specific protein-protein interactions involved. The undergraduate research students in the lab utilize a combination of protein biochemistry, fluorescence spectroscopy, and cell/molecular biology to determine specific protein interactions that dictate important events in the cell.



In light of significant student interest in the areas of biochemistry and molecular biology at GVSU, there had been consideration in starting a club that focused on student research opportunities and potential careers. After some discussions with Marilee Benore-Parsons (the Regional UAN Director for the North-Central Region), Dr. Wallar introduced an undergraduate affiliate of the ASBMB at GVSU. After attending the 2004 ASBMB national meeting in Boston, the idea that GVSU would join the ASBMB was solidified. At the national meeting, the undergraduate poster competition was very impressive, and it was apparent that there was a

substantial group of professors in attendance who truly cared about undergraduate education. During this year's fall semester, the high degree of student interest in biochemistry and molecular biology came to fruition with the creation of an official GVSU undergraduate affiliate of the ASBMB. Currently, more than 45 students actively participate in sponsoring visiting speakers from academia and industry positions, as well as exploring future careers in biochemistry and molecular biology. This year, about 200 students from five different departments have attended presentations by scientists from the University of Michigan, Michigan State University, Hope College, Calvin College, and Van Andel Institute. In addition, the president of the GVSU undergraduate affiliate, Jessica Schoenherr, recently presented her research in the undergraduate poster competition at the annual meeting in San Diego. After seeing such an impressive display of research by undergraduate students from all over the nation, aculty and students from Grand Valley State University hope to see you at the next national ASBMB meeting in San Francisco.



## JBC in the Classroom.

### Using primary literature in a Protein Structure, Function and Biophysics Course: Part I Enzyme Kinetics and Regulation

The first 2 weeks in the advanced course in [Protein Structure, Function and Biophysics](#) that I teach in the Biochemistry and Molecular Biology major at the University of Richmond serves several purposes. The first is to build upon the fairly typical and elementary treatment of enzyme kinetics and ligand binding that they see in a typical introductory biochemistry course where they are exposed to simple Michaelis-Menten or Lineweaver-Burk plots and the treatment of one-substrate kinetics and simple reversible inhibitors and elementary concepts of enzyme regulation. The second is to integrate information from different types of studies to help answer functional questions. The third is to introduce an analysis and appreciation of the primary literature that will be built upon throughout the course.

The formal topics covered in the first three lectures of the course are “advanced initial rate kinetics,” “rapid reaction approaches,” and “ligand binding.” Each lecture is 75 min, and the first 15-20 min are spent discussing a recent paper from the *Journal of Biological Chemistry*, each student has a copy of the paper and should have at least looked at it before class, to illustrate the types of information that can be obtained and what types of experiments/analysis are necessary to get the appropriate information.

For this block of material this semester I will use three papers:

1. **“Identification of Six Novel Allosteric Effectors of *Arabidopsis thaliana* Aspartate Kinase-Homoserine Dehydrogenase Isoforms. PHYSIOLOGICAL CONTEXT SETS THE SPECIFICITY”** by Gilles Curien, Stéphane Ravel, Mylène Robert, and Renaud Dumas. THE JOURNAL OF BIOLOGICAL CHEMISTRY VOL. 280, NO. 50, pp. 41178–41183, December 16, 2005.
2. **“Calcium Binding by the Essential Virulence Factor BAD-1 of *Blastomyces dermatitidis*”** by T. Tristan Brandhorst, Gregory M. Gauthier, Richard A. Stein, and Bruce S. Klein. THE JOURNAL OF BIOLOGICAL CHEMISTRY VOL. 280, NO. 51, pp. 42156–42163, December 23, 2005.
3. **“Influence of the Unusual Covalent Adduct on the Kinetics and Formation of Radical Intermediates in *Synechocystis* Catalase Peroxidase. A STOPPED-FLOW AND EPR CHARACTERIZATION OF THE MET<sup>275</sup>, TYR<sup>249</sup>, AND ARG<sup>439</sup> VARIANTS”** by Christa Jakopitsch, Anabella Ivancich, Florian Schmuckenschlager, Anuruddhika Wanasinghe, Gerald Pörtl, Paul Georg Furtmüller, Florian Rüker, and Christian Obinger. THE JOURNAL OF BIOLOGICAL CHEMISTRY VOL. 279, NO. 44, pp. 46082–46095, October 29, 2004.

Each of which introduces certain of the concepts I want to get across to the class.

The first paper lets me talk about initial rate kinetics of multisubstrate enzymes and how one can experimentally determine the true  $K_m$  values for each substrate as well as developing in more detail the concepts of regulation, allostery, and the use of the Hill equation. This discussion extends to when and under what conditions  $K_m$  values reflect actual binding. (Details of the lecture coverage are available from the course web site [<http://www.richmond.edu/~jbell2/chem329-schedule.htm>].) I follow up the lecture material with a problem set that requires a quantitative analysis of activity,  $V_{max}$ ,  $K_m$ , and the Hill constant  $n$  for a regulated enzyme (see the section on “Quantitative Data” in this issue of Enzymatic for the problem sets).

The second paper introduces ligand binding from an easy to understand approach using equilibrium dialysis as well as some sophisticated mass spectrometry and allows me to then develop other direct methods of studying binding as well as indirect methods such as fluorescence titrations. The comparison of both types of approaches brings up the important considerations of stoichiometry and dissociation constants and allows me to introduce concepts of heterogeneity in binding sites for the same ligand. (Again I use a comprehensive problem set to help with the quantitative aspects of data analysis.)

The final paper I use in this sequence introduces rapid reaction approaches as well as more sophisticated quantitative data analysis and is again supplemented by a problem set. (I use real data obtained in our laboratory where the best fit to the primary data requires the use of a double exponential analysis, these data are provided in this issue in the Quantitative Data Section.)

## Regional UAN Meetings Select Students for Travel Awards to San Francisco

*In October two regions of the UAN, the Southeast and the Northwest regions, held UAN-sponsored research symposia where undergraduate research was featured. At each event posters were judged, and four travel awards were given for the students to attend the 2006 San Francisco ASBMB Meeting and present their work both in the Undergraduate Research Poster Competition and in the regular scientific poster sessions.*

### Southeast Region

#### VCU Department of Biochemistry Hosts 3<sup>rd</sup> Undergraduate Research Symposium/ Inaugural Integrated Cellular and Molecular Signaling (ICMS) Research Retreat

On October 28-29, 2005, dozens of biomedical scientists assembled at the MCV to attend the combined Undergraduate Research Symposium/ ICMS Research sponsored by the VCU Department of Biochemistry. The event started on Friday with a keynote address by **Dr. Phillip Hylemon**, Department of Microbiology and Immunology, VCU, entitled "[HIV Protease](#)

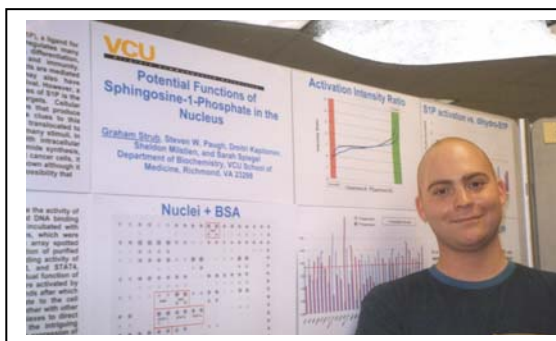


campus  
Retreat  
evening

[Inhibitor](#)  
[S](#)

[Activate the Unfolded Protein Response in Macrophages: Implication for Atherosclerosis and Cardiovascular Disease.](#)

This event was followed by a poster session on Saturday, October 29 that featured more than 50 posters by undergraduate, graduate, and postdoctoral researchers. The posters featured a variety of topics, including the enzymology of dehydrogenases, phospholipases, and lipid metabolism, the regulation of gene expression, lipoprotein



structure and function, and signal transduction in bladder, neuronal, and immune cells. A panel of faculty judges reviewed the posters and selected the most outstanding presentations in the fields of metabolism, immune response, cancer biology, and neurobiology. Congratulations to the winners in each of these categories, **Natasha Cover** (undergraduate), **JiaDe Yu**

(undergraduate), **Sarah Wacker** (undergraduate), **Tsega Belachew** (undergraduate), **Rachael Griffiths** (graduate), **Jill Ford** (graduate), **Sunita Gopalan** (graduate), **Zendra Lee** (graduate), **Xueping Zhang** (postdoctoral), **Carole Oskeritzian** (postdoctoral), and **Aki Mikami** (postdoctoral). Each of these individuals received a certificate to commemorate his/her award. In addition, the

undergraduate winners were awarded \$400 travel awards to the 2006 American Society for Biochemistry and Molecular Biology meeting in San Francisco.

Many thanks to the students, staff, and faculty who organized and attended these two successful events! Please mark your calendars for Friday October 27 and Saturday October 28, 2006 for the 4<sup>th</sup> Undergraduate Research Symposium/ICMS Research Retreat.

### Northwest Region

Minnesota State University Moorhead and Concordia College Host Northwest UAN/ASBMB Undergraduate Meeting

Minnesota State University Moorhead and Concordia College collaborated to host the first Northwest Regional Undergraduate Affiliate Network of the ASBMB. Over 55 participants attended the meeting. Undergraduates from universities and community colleges throughout Minnesota, North Dakota, and



South Dakota were invited to present their research at the UAN meeting. Nine different institutions were represented with 24 posters presented. The meeting started Friday night with an excellent seminar on human papillomavirus by Dr. Don Sens from the Pathology Department of the University of North Dakota School of Medicine. Saturday's poster session was well attended. "I wasn't certain how a meeting early in the school year would work out," said Joseph Provost, one of

the meeting organizers. "But it is nice to see the students were excited and learned much more about their project by having this meeting at this time" Provost said. Several students were able to present their summer work at this meeting. Some even used the meeting to help them to prepare their research to submit an abstract to the national ASBMB/Experimental Biology Meeting this spring. "The interaction between students was impressive," said Mark Wallert, another organizer and one of the coordinators of the Northwest Regional UAN. Wallert commented "the students were so busy visiting posters and learning about their research, it was a shame to have them move from the poster presentation to take time to eat!" Following the poster session and lunch, a panel of industry experts presented the future of biotechnology in the Red River Valley of North Dakota and discussed how the scientists each became an industry leader. "It was interesting to learn how academics and industry can work together," said David Mork, a Concordia biochemist and co-host. Four Travel Awards sponsored by the ASBMB were presented to outstanding presentations. Winners included the work by Melaine Antonio from Turtle Mountain Community College, ND. Melanie's poster was on "Conducting Genetic Research in American Indian Communities: Promoting Dialog." Also winning UAN Travel Awards were Eun Hyuk Chang from MSU Moorhead for his studies on genomic analysis on liverworts and minnows. Jennifer Taves, also from MSU Moorhead, won an award for her work on MMP9 signaling in lung cells. Jordan P. Karlstad from Mayville State University, ND, won for his work focusing on the



detection of single nucleotide polymorphisms using fluorescent lifetime probes. Each winner will be presenting his or her work at the Undergraduate Poster Session this spring at the ASBMB Annual Meeting in San Francisco.





## ***Resources for Educators***

***Peer-reviewed Journals publishing articles of interest to Educators in the Molecular Life Sciences***

<http://www.cellbioed.org/>  
<http://jchemed.chem.wisc.edu/>  
<http://www.bambed.org/>

Monographs on Education in the Molecular Life Sciences

## ***HHMI Focus and Resources for Education***

<http://www.hhmi.org/resources/educators.html>

## ***Links to Other Society Education Activities and Resources***

The Biochemical Society, UK

<http://www.biochemistry.org/education/default.htm>

## **Summer Research Opportunities for Undergraduates**

The National Science Foundation funds undergraduate research opportunities in a wide variety of ways. If you are looking for a summer research opportunity it is useful to know the different ways that you can get involved with NSF-funded research in the molecular biosciences.

The first one you probably already know, if it applies to your situation: if a faculty member in your institution has NSF support for her or his research they may already have support for summer students built in to their budget. If they don't have such a budget line item then they can apply to their program director at NSF for a supplement to support one or more undergraduates doing research in their laboratory for the summer. All you have to do is convince the faculty member to take you into their laboratory if they already have funding or to apply for a supplement if they don't. In the later case, time is of the essence. Program directors usually want to make these supplementary allocations well before the summer starts, and usually they need to know who is applying for such supplements by February/March, so the sooner you get started the better.

The second mechanism is to find an REU (Research Experience for Undergraduates) Site program. NSF funds many such programs around the country, and the current ones are listed at the NSF web site. The link for Biology sites is:

[http://www.nsf.gov/crssprgm/reu/list\\_result.cfm?unitid=5047](http://www.nsf.gov/crssprgm/reu/list_result.cfm?unitid=5047)

That for chemistry sites is:

[http://www.nsf.gov/crssprgm/reu/list\\_result.cfm?unitid=5048](http://www.nsf.gov/crssprgm/reu/list_result.cfm?unitid=5048)

These programs usually have deadlines in late January or early February, and details of individual programs can be obtained through the NSF links.

Finally, you should be aware that any NSF-funded Principal Investigator can apply for supplements to support undergraduate summer research whether the student is from that institution or another. If you have the initiative to find someone who is doing the type of research that you want to get involved with you should contact them and ask if they would be willing to take you into their lab. They may not know that they can apply for a supplement to support you, but they will be impressed that you know and that may well help them say yes. Lists of all NSF-funded grants are again available from the NSF web site, and you can browse them to find people doing interesting science or that are in locations or schools where you might like to spend a summer. Either way, if you want to take the initiative, do it now because just like the supplements discussed above NSF Program Directors want to know who is applying for such supplements in February/March.

## **Resources for Teaching Bioinformatics, Proteomics, and Molecular Visualization**

### General Web Sites

PubMed

<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi>

NCBI

<http://www.ncbi.nlm.nih.gov/>

EMBL-EBI: European Bioinformatics Institute

<http://www.ebi.ac.uk/services/>

### Gene & Gene Sequence Based Approaches

NCBI

<http://www.ncbi.nlm.nih.gov/>

EMBL-EBI: European Bioinformatics Institute

<http://www.ebi.ac.uk/services/>

PubMed

<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi>

### Protein Alignment and Homology Approaches

ClustalW

<http://www.ebi.ac.uk/clustalw/>

### Working with Data

[http://www.richmond.edu/%7Ejbell2/Genomics\\_Analysis\\_of\\_the\\_HIV\\_Protease.html](http://www.richmond.edu/%7Ejbell2/Genomics_Analysis_of_the_HIV_Protease.html)

### Molecular Visualization

VMD

<http://www.ks.uiuc.edu/Research/vmd/>

Protein Explorer

<http://www.umass.edu/microbio/chime/pe/protexpl/frntdoor.htm>

3D Macromolecule Analysis & Kinemage

<http://kinemage.biochem.duke.edu/>

## Homology Modeling

<http://www.umass.edu/microbio/chime/explorer/homolmod.htm>

<http://cl.sdsc.edu/hm.html>

<http://www.biosino.org/mirror/swift.embl-heidelberg.de/course/default.htm>

<http://www.usm.maine.edu/~rhodes/SPVTut/>

## Graphical Representation and Analysis of Structure Server

<http://honiglab.cpmc.columbia.edu/GRASS/main.html>

<http://www.eslc.vabiotech.com/hint/>

## Barry Honig Lab

<http://honiglab.cpmc.columbia.edu/>

## Microarrays

<http://www.microarrays.org/>

<http://www.gene-chips.com/>

## GCAT

<http://www.bio.davidson.edu/projects/GCAT/gcat.html>

## 2D PAGE

<http://us.expasy.org/ch2d/>

<http://www.wellcome.ac.uk/en/genome/technologies/hg17b013.html>

## UCSF Mass Spectrometry Facility

<http://donatello.ucsf.edu/>

## Protein Prospector

<http://prospector.ucsf.edu/>

## Prediction of Limited Proteolysis of a Protein

<http://wolf.bms.umist.ac.uk/npred/intro.html>

**How to Join ASBMB as a student member and how to form an Undergraduate Affiliates Program to join the UAN**

<http://www.asbmb.org/ASBMB/site.nsf/Sub/UndergradAffiliates?Opendocument>