



Undergraduate Newsletter

The Department of Biochemistry and Molecular Biology

In its efforts to keep the BMB undergraduate student body informed about people, programs and events in the BMB Department, the *Undergraduate Newsletter* is pleased to offer a series of interviews that will hopefully provide a new dimension to the BMB faculty who teach departmental courses and to the exciting areas of research conducted in their labs with the assistance of undergraduates, graduate students and postdoctoral fellows. We hope our readers will find this feature both interesting and, perhaps, valuable to future endeavors. Herewith, we present —

An Interview with Dr. Paul Babitzke

UN (Undergraduate Newsletter): What is the goal of the research being conducted in your laboratory?

Dr. BABITZKE:

The ability to switch from utilizing one compound as an energy source to another, or to adjust the biosynthetic capacity of other nutrients, is crucial for bacterial survival. The primary means of adapting to fluctuations in nutrient availability is to regulate expression of the genes that encode enzymes required for the utilization or synthesis of specific compounds. Thus, understanding the molecular mechanisms that are responsible for regulating gene expression is of fundamental importance. Several genes are known to rely on RNA structure and RNA binding proteins in controlling their expression, indicating that the crucial regulatory events take place after transcription initiation. The goal of the research in my laboratory is to identify bacterial regulatory systems that involve RNA structure and RNA binding proteins, and to elucidate the underlying regulatory mechanisms.

We have been investigating the regulatory mechanisms responsible for controlling tryptophan biosynthesis and transport in *Bacillus subtilis*. The *B. subtilis* tryptophan biosynthetic and transport genes are regulated in response to changing levels of tryptophan by TRAP, the *trp* RNA-binding attenuation protein. TRAP regulates expression of these genes by transcription attenuation and translation control mechanisms. Tryptophan-activated TRAP binds to multiple (G/UAG) trinucleotide repeats in target transcripts, thereby promoting premature transcription termination (transcription attenuation) or blocking ribosome binding (translation control). We are also investigating a global regulatory system that controls carbon metabolism and cell motility in *Escherichia coli*. The carbon storage regulatory system (Csr) consists of three major regulatory components. CsrA is an RNA binding protein that inhibits glycogen biosynthesis and peptide transport by blocking translation of *glgC* and *cstA*, respectively. Conversely, CsrA activates translation of *flhDC*. FlhDC, in turn, activates expression of several genes involved in flagella biosynthesis. The other two regulatory components of the Csr system include CsrB

RNA and CsrC RNA which function as antagonists of CsrA by sequestering this protein and preventing its action.

UN: What are the larger implications/applications for the findings of your research?

Dr. BABITZKE:

The studies in my laboratory have revealed some of the fundamental principles that dictate protein-RNA recognition, as well as the elucidation of novel regulatory mechanisms. It has always been my expectation that our studies would provide a framework for other studies. For example, it is now apparent that regulation of HIV gene expression involves a transcription attenuation mechanism that is similar to the attenuation mechanism that regulates the *B. subtilis trp* genes. Moreover, several neurological diseases are associated with expanded trinucleotide repeats. In the case of myotonic dystrophy, it appears that disease progression is caused by sequestration of a CUG repeat RNA binding protein. It is also likely that sequestration of CAG and CGG repeat RNA binding proteins contribute to the progression of Huntington's disease and fragile X syndrome, respectively.

The declining effectiveness of existing antimicrobial therapies, due to the emergence of antibiotic resistant strains of bacteria, makes the discovery of novel therapeutic approaches particularly relevant for human health. The Csr system controls virulence genes of mammalian pathogens, such as *Legionella pneumophila*, *Proteus mirabilis* and *Salmonella enterica*. There is also evidence for regulatory interplay between Csr and quorum-sensing metabolites which are soluble elicitors of virulence factors. Thus, a mechanistic understanding of the *E. coli* Csr system could lead to the design of a novel class of antibiotic.

UN: Why did you choose to pursue a career in academic research and why in this particular field?

DR. BABITZKE:

When I entered college I did not have a clear direction in what I wanted to pursue academically. Fortunately, the university that I attended placed a strong emphasis on general education. As fate would have it I found myself in a human biology

See, BABITZKE, Page 2

New Faculty Join Department

The BMB Department recently conducted a search to recruit faculty for new positions in the areas of **Genomics, Proteomics** and **Bioinformatics**. As a result of that search, 2 new faculty have joined the BMB Department. A second search was launched to recruit a faculty member in the area of **Structural Biology**. As a result of these searches, 4 new faculty have joined the BMB Department.

Dr. Emine Koc received her B.S. degree in Biochemistry and Chemistry from Ege University in Izmir, Turkey; she also earned her M.S. in Biochemistry from Ege University; her Ph.D in Chemistry (Biochemistry) with a Minor in Toxicology was conferred by New Mexico State University. Dr. Koc took two post-doctoral positions at the University of North Carolina, first in the Department of Biochemistry and Biophysics and then in the Department of Chemistry. In her future research, Dr. Koc plans "to combine molecular biological and biochemical methods with 'state-of-the-art' proteomics techniques to investigate post-translational modifications, protein-protein interactions, and protein-RNA interactions focusing on the mitochondrial translational apparatus in normal cells, in disease states and in apoptosis." You may welcome Dr. Koc to Penn State in her office in 103 Althouse.

Dr. Anton Nekrutenko comes to Penn State from a post-doctoral position in the Department of Ecology and Evolution at the University of Chicago where he was a Research Associate in the Computational Genomics Group working on the Computational Genomics of Eukaryotes. Dr. Nekrutenko received his M.S. in Biochemistry and Molecular Biology from Kiev State University, Ukraine, and his Ph.D. in Biology from Texas Tech University. Dr. Nekrutenko lists his 'interests' as: comparative genomics of eukaryotes, evolution and function of "junk" DNA, compositional properties of eukaryotic genomes, identification of protein-coding genes and non-protein-coding genes, identification of regulatory elements (promoters and enhancers), unification of genetic databases, and popularization of genome

analysis tools via Web-based interface. You will find Dr. Nekrutenko's office in 505 Wartik Lab which houses the [Center for Comparative Genomics](#).

Professor **Arthur M. Lesk**, who comes to Penn State from the University of Cambridge, also joins the Genomics/Proteomics/Bioinformatics group and will have his office in Wartik 512A. Dr. Lesk's research focuses on the general principles of protein structure and evolution, including "comparisons of sequences and structures across protein families, protein conformational changes, analysis of binding sites and application to prediction of function, and mechanisms of molecular recognition." Before moving to Cambridge, Dr. Lesk served as Group Leader in the Biocomputing Program of the European Molecular Biology Laboratory in Heidelberg, Germany. He has authored several books: *Case Studies in Chemical Computing*, *Introduction to Physical Chemistry*, and *Introduction to Protein Architecture: The Structural Biology of Proteins*. He has also edited *Computational Molecular Biology: Sources and Methods of Sequence Analysis*.

Dr. Katsuhiko Murakami comes to Penn State as a new faculty member in the Structural Biology group. Dr. Murakami received his B.Sc. and M.Sc. in chemistry from Yamaguchi University and his Ph.D. in molecular biology from The Graduate University for Advanced Studies, Japan. Most recently, Dr. Murakami has done post-doctoral work at The Rockefeller University. His research has two primary goals: 1) to understand the structural basis for the transition from initiation to elongation transcription in bacterial RNA polymerase, and 2) to undertake crystallographic studies of influenza virus RNA-dependent RNA polymerase. Dr. Murakami is working temporarily in 401 Althouse but will move to his permanent office/lab complex in 006 Althouse after renovations are completed.

We extend a most cordial welcome to Penn State to our 4 new faculty members.

BABITZKE

From Page 1

course during my first quarter of college. I became fascinated with the intricacies of the human body. I subsequently enrolled in a genetics course and I was stunned by the realization that the fundamental mechanisms that were first discovered in bacteriophage were essentially identical to the mechanisms later discovered in human cells. I was enamored not only with the facts but also with the scientific discovery behind the facts. Despite having never carried out an experiment outside of a laboratory course, I knew that I had to pursue a career in research. I chose to study post-transcriptional control of gene expression because it was an area of research that was in its infancy when I started graduate school. I am amazed at how this field has exploded in the past two decades. It is apparent that basic discoveries made in academic laboratories are largely responsible for providing the fundamental principles on how cells function. Furthermore, academic research allows the freedom to pursue any research area. However, the most important reason for me in choosing an academic career was my desire to have the opportunity to teach both in the laboratory and in the classroom. It is difficult to describe the excitement

that I feel when one of the members of my lab makes a new discovery or when one of my genetics students grasps the deeper implications of what I am teaching. While I could carry out research in an industrial setting or research institute, I wouldn't have the opportunity to teach in the classroom.

UN: What do you look for in selecting an undergraduate student to do research in your lab?

DR. BABITZKE:

My primary requirements are that the student be interested in pursuing a career in experimental science and that they are motivated. It is exceptionally difficult for many undergraduate students to effectively juggle a full course load with the demands placed on them by their laboratory commitments. I tell any interested student that the lab must be their highest priority. As chair of our graduate student admissions committee, I view a positive laboratory experience as being the single most important component of a graduate application. I encourage all undergraduate students that have an interest in pursuing graduate education to avail themselves of the research opportunities that they have at Penn State.

Trace Selected as McNair Scholar

Anthony Trace (Biotc '04) has been named a McNair Scholar. He joins over 4000 other McNair undergraduates in 156 McNair Post-Baccalaureate Achievement Programs nationwide. McNair scholars prepare for graduate/doctoral study through a program of seminars, workshops and graduate school visits. The scholarship also affords recipients the opportunity to prepare, conduct and present research. Anthony is conducting research on enzyme kinetics in the laboratory of Dr. J. Martin Bollinger.

Attention CLS Juniors!!

This year's orientation meeting for all Juniors interested in the Clinical Laboratory Science option will be held on **Tuesday, September 16**, in Room 112 S. Frear Laboratory. Information concerning the senior year practicum will be provided at that time. All students in the CLS Option of the Biotechnology major who will have completed the non-clinical course requirements of the major by the end of SP04 are eligible for admission to the hospital practicum and **should attend this meeting**. Contact Dr. Mohr if you plan to apply for the practicum but are unable to be present that evening.



BMB Students Win NSF Fellowship

Each year, about 900 senior undergraduate and first-year graduate students are selected as recipients of National Science Foundation Graduate Fellowships. Students are chosen from the mathematical, physical, biological, engineering, and behavioral & social sciences. The awards carry a stipend of \$27,500 plus a \$10,500 cost-of-education allowance for a 12-month period. This Spring, the BMB Department was honored to have two senior undergraduates and two former undergraduates (now completing their first year of graduate study) named as NSF Fellows.

Heather Agnew (BMB '03), a Schreyer Scholar, conducted the research for her senior thesis in the laboratory of Professor Mary Beth Williams of the Chemistry Department. Some readers of the SP03 *Newsletter* will recall that Heather was also named the recipient of a Gates/Cambridge Scholarship. After completing her work at Cambridge University, Heather will undertake graduate study at Cal Tech.

Catherine Vrentas (BMB '03), also a Schreyer Scholar, carried out her undergraduate research in the laboratory of Dr. David Gilmour. Catherine is also the recipient of a Howard Hughes Predoctoral Fellowship, which supports up to five years of study toward the doctoral degree in the life sciences. Catherine will pursue her Ph.D at the University of Wisconsin where she will continue her study of chromatin regulation.

Kim Moran (BMB '01) is a graduate student at New York University where she is studying neuroscience.

Kenneth Witwer (Ger '99, Int Pl '99, BMB), a former Schreyer Scholar, is undertaking graduate study in the Department of Molecular Biology at the Medical Institute of Johns Hopkins University.

It should be noted that the NSF has two categories of students it recognizes. The first group consists of actual *recipients* of a Fellowship. The second group is comprised of students who also have exceptional credentials but are not awarded a Fellowship. This is the 'Honorable Mention' group. One indicator of the quality of a university or college's undergraduate program is the number of awardees and honorable mentions selected by NSF. Among all Big Ten schools, Penn State tied for first place this year with the University of Illinois in number of winners but is one better than the Illini in honorable mentions. Among Pennsylvania schools, only Carnegie Mellon has more winners, although it is tied with PSU in honorable mentions. All of this is to say that the quality of a Penn State education – and particularly that provided in the BMB Department – is being recognized nationally. Obviously, this indicator is based simply on numbers. Behind those numbers, however, are the *real* stories of committed students who work diligently to *earn* the honors that come to them and thereby to the Department and University. ***Congratulations to winners and honorable mentions alike!***

Join a Club ... Become Involved... Learn More about your Future Profession!!

The BMB Department supports two undergraduate organizations – The Biochemistry Society and the PSU student chapter of The American Society for Microbiology. Undergraduates of all semester standings are urged to become an active member of one or both clubs. Club activities provide a venue for meeting other students in an informal setting, for learning more about career opportunities through special speakers, for providing service to the department, and for many other possibilities limited only by the collective imagination and willing cooperation of each member of the group. Watch for announcements of organizational meetings, and plan to be an *active participant* in your student club.



Course Matters.....

Following are a few 'odds and ends' regarding some courses that may be of particular interest to students of Junior and Senior standing:

BMB(VSc) 433, Molecular Toxicology: This course, which has previously been taught only in the Fall semester is moving to Spring semester and will be offered, subsequently, ONLY in the Spring semester. If you wish to take this elective, be sure to plan your schedule accordingly.

BMB 446, Laboratory in Molecular Genetics II: All BMB SENIORS who will be graduating FA03 or SP04 are **REQUIRED** to take BMB 446. Unless they have already completed the course, all BMB majors planning to graduate in FA03 OR SP04 should NOW be enrolled in BMB 446 because it is being offered ONLY in Fall semester.

Biotc 479, Methods in Biofermentations: In our SP03 *Newsletter*, we announced that Biotc 479 would be moving from its traditional Spring

semester offering to a Fall ONLY offering. We are now pleased to announce that Methods in Biofermentations will be taught in BOTH Fall and Spring semesters! We trust this new pattern of offering will reduce class size while providing more flexibility in scheduling for our Biotc majors.

In preparation for SP04 registration, a reminder of some new course offerings may be appropriate...

Biotc(Agro) 460, Molecular Genetics of Transgenic Plants: This is a new crosslisted offering. The course complements Biotc 459, in particular, and will make an excellent elective for Biotc majors who might be interested in the area of plant/agricultural biotechnology. The course will be offered in SP04, T 2:30-3:45 and R 2:30-5:30. See the online version of the SP03 *Newsletter* at www.bmb.psu.edu for a more detailed description of the course.

ABE 468, Microbiological Engineering: While this is a course that Bio-

technology majors should find of great value, it is also an excellent course for Microbiology majors who might have an interest in applied aspects of the discipline. The course employs a quantitative approach to commonly encountered problems in the use of microorganisms for the production of commercially valuable products. As such, it is an especially strong complement to Biotc 479. ABE is offered only in Spring semesters. In SP04, it will be offered MWF 11:15-12:05 and T 10:10-12:05. A full description of the course can be found at the department web site mentioned above.

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www.bmb.psu.edu

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BMB Undergraduate Newsletter is a publication of the Department of Biochemistry and Molecular Biology. Items for inclusion in the newsletter should be sent to BMB Undergraduate Newsletter, 108 Althouse Laboratory, University Park, PA 16802 Tel. (814) 865-5497; Fax. (814) 863-7024. U.Ed. SCI 04-12
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