



## A Workshop for Predicting Chemical Fate in the Environment

### Introduction

The University of Minnesota Biocatalysis/Biodegradation Database (UM-BBD, <http://umbbd.msi.umn.edu/>, Ellis et al., 2006), freely available on the web for over a decade, contains information on the bacterial metabolism of chemicals, knowledge that is used to both degrade pollutants and biosynthesize industrial chemicals in non-polluting processes. Eight years ago, a project was begun to use the knowledge in the UM-BBD to predict the fate of chemicals in the environment, which has led to development of the University of Minnesota Pathway Prediction System (PPS, <http://umbbd.msi.umn.edu/predict/>). As part of this project, we have held three PredictBT workshops convening biodegradation and computer experts to help guide PPS development. This proposal requests Consortium support to add to existing Graduate School support for the 4<sup>th</sup> PredictBT workshop, focused on integrating genomic and thermodynamic information into the PPS. This will require expertise different than what we have obtained previously; thus, a new workshop with different expert scientists is essential. The workshop will be held at the University of Minnesota, May 4-5, 2007.

### Background

The University of Minnesota has hosted research programs on microbial biocatalysis and biodegradation (collectively, biotransformations) for over 40 years. Currently, biocatalysis and biodegradation are priority areas under the President's University-wide initiatives. The Institute for Renewable Energy and the Environment, the Center for Microbial and Plant Genomics, and the BioTechnology Institute are part of the constellation of resources working under this initiative.

Another of the University's jewels in this research area is the University of Minnesota Biocatalysis/Biodegradation Database (UM-BBD, <http://umbbd.msi.umn.edu/> (Ellis et al., 2006)). The UM-BBD, freely available on the web, has been used worldwide for over 10 years. The UM-BBD contains information on the bacterial metabolism of chemicals, knowledge that is used to both degrade pollutants and biosynthesize industrial chemicals in non-polluting processes.

### Detailed Plan

Eight years ago, a project was begun to use the knowledge in the UM-BBD to predict the fate of chemicals in the environment. As part of this project, we have held three PredictBT workshops convening biodegradation and computer experts (<http://umbbd.msi.umn.edu/predictbt/>). The first, held at the University of Minnesota in 1997 (Wackett et al., 1999), led to several publications (Wackett & Ellis, 1999; Hou et al., 2003; Hou et al., 2004) and the implementation of the Pathway Prediction System (PPS, <http://umbbd.msi.umn.edu/predict/>), a software tool for biodegradation prediction. In 2005, two additional workshops were held, funded by the European Union (EU); the system is heavily used by industry and environmental regulatory agencies in Europe. The first EU-funded workshop was held at the University of Minnesota in May 2005. The second was held in Brussels, the EU capital, in December 2005. These workshops have improved the PPS, brought greater recognition to the University and the system, and have contributed to attracting research funding from Lhasa Limited, a company in the United Kingdom. Following the last workshop, one participant, Assistant Professor Kathrin Fenner from the Swiss Federal Institute of Technology received a grant to the Swiss National Science Foundation to come to Minnesota for one year to work on the PPS; she started in November 2006.

We are continuing to develop the PPS with funding from Lhasa Limited, and believe it is essential to hold periodic workshops to guide and ground development of the system. The knowledge required to predict environmental fate of chemicals is more extensive than that possessed by any single person, requiring expertise in physical chemistry, organic chemistry, biochemistry, microbiology, molecular biology, and computer science. Our past workshops have brought this expertise together and further teach us what

users want in such a system. The next workshop will be highly focused on integrating genomic and thermodynamic knowledge into chemical fate prediction.

The workshop will include 10 participants. Most can be from the US but we wish to host 2 European experts because there is significant activity in Europe in this research area. We would also like to include a Japanese expert; Dr. Ken Valentas, Director of the BioTechnology Institute states in his attached Letter of Support that, if an appropriate candidate can be found, he would cover the cost based on his Institute's strong ties with Japanese research institutions. UM students have attended previous UM workshops; Joint Degree students interested in the topic can attend this workshop and interact informally with the participants.

The workshop will be held at the University of Minnesota, on May 4-5, 2007, two years after the last US workshop. As with past workshops, participants will be asked to complete "homework" prior to the workshop. We have been gratified to find that most do complete this work; this increases workshop productivity.

The main goal of the workshop will be to interject modern concepts in genomics and thermodynamics into metabolic pathway prediction. Previous efforts have focused on individual steps in a pathway. To better prioritize which pathways are most likely in the environment, emerging genomic and thermodynamic data can be used to say which are most plausible based on biological and chemical logic, respectively.

A second goal of the workshop is to foster research collaborations between and amongst participants. Besides the collaboration emanating from workshop 3 with Kathrin Fenner, Swiss Federal Institute of Technology, two other collaborations are currently underway between UM PPS staff and former workshop participants: Vassily Hatzimanikatis, Northwestern, workshop 2; and Stefan Kramer, Technical University Munich, workshop 3. The workshops greatly facilitated these research collaborations. Based on the new theme of this coming year's workshop, we anticipate that most of the participants will be people who have different expertise, and thus will not have attended previous workshops. From past experience, this should lead to the development of new ideas and collaborations.

### **Timeline**

- February 2007 – Prepare participant list, begin inviting participants, update list as people accept or decline; reserve room.
- March 2007 – Prepare participant "homework" to be completed before the workshop.
- April 2007 – Distribute homework, arrange for meals, handouts, complete agenda.
- May 2007 – Hold workshop May 5-7; write and distribute workshop report.

### **References**

Ellis, L.B.M., Roe, D., Wackett, L.P. (2006) The University of Minnesota Biocatalysis/ Biodegradation Database: the first decade. *Nucleic Acids Research*, **34**: D517 – D521.

Hou, B.K., L.P. Wackett, and L.B.M. Ellis (2003) Microbial pathway prediction: A functional group approach. *J. Chem. Inf. Comp. Sci.* **43**:1051-1057.

Hou, B.K., L.B.M. Ellis, and L.P. Wackett (2004) Encoding microbial metabolic logic: Predicting biodegradation. *J. Ind. Microbiol. Biotechnol.* **31**:261-272.

Wackett, L.P., L.B.M. Ellis, S.M. Speedie, C.D. Hershberger, H-J. Knackmuss, A.M. Spormann, C.T. Walsh, L.J. Forney, W.F. Punch, T. Kazic, M. Kanehisa, and D.J. Berndt (1999) Predicting microbial biodegradation pathways. *ASM News* **65**:87-93.

Wackett, L.P. and L.B.M. Ellis (1999) Predicting biodegradation. *Environ. Microbiol.* **1**: 119-124.

### **Needs Justification:**

The first workshop was funded by a non-recurring UM Center grant. The second and third workshops were funded by a non-recurring EU 6<sup>th</sup> Framework grant. Support for the UM-BBD and its PPS at present comes from a grant from Lhasa Limited, which ends August 30, 2006. We have been notified that a noncompetitive renewal application (Sept 1, 2006 – Aug 30, 2009) will be favorably received at the present rate; that is, with no increase in funds for another PredictBT workshop. The BioTechnology Institute encourages work in this area, supports the idea of the workshop, is willing to provide administrative support for it, interface it with its NIH training grant trainees, and potentially support a Japanese collaborator who can attend the workshop, but cannot fund the entire workshop itself (see Letter of Support from Ken Valentas).

### **Biographies:**

#### **Lynda B.M. Ellis**

Dr. Ellis is a computational biologist who works with life science colleagues to develop databases and tools to solve important biological problems. With colleague Larry Wackett in the Biochemistry, Molecular Biology, and Biophysics Department, she has developed the University of Minnesota Biocatalysis/Biodegradation Database (<http://umbbd.msi.umn.edu/>), and supervises the student programmers and data entry people who develop and maintain the database and its Pathway Prediction System (<http://umbbd.msi.umn.edu/predict/>). She is Director of Graduate Studies for the Bioinformatics Graduate Program (<http://www.binf.umn.edu/>), and is a full member of the Health Informatics, Microbial Engineering, and Microbiology, Immunology, and Cancer Biology graduate programs.

#### **Lawrence P. Wackett**

Dr. Wackett studies microbial catabolic enzymology and functional genomics: fundamental biological mechanisms, enzyme evolution and applications for biotechnology. More than ten million organic compounds are known. Most of them do not accumulate in the environment, and this suggests they serve as substrates for one or more microbial enzymes. Microbial enzymes represent the most diverse biocatalytic potential on Earth. Our knowledge of what nature has wrought is increasingly being used for bioremediation to detoxify hazardous waste and biocatalysis to synthesize specialty chemicals. Studies of microbial metabolism are also important in the context of functional genomics. Microbial genome sequencing projects are leading to the accumulation of genes with unknown function. Reverse genomics approaches are being used to discover a broad range of new microbial functions that will be used to identify unknown genes derived from the genome sequencing projects.

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**Budget for Faculty Proposals**

**Project Title:** \_\_\_\_\_

**Instructions:** add rows for multiple personnel.

Category	Description & justification	Requested funding	Matching/other funding		
		Amount	Amount	Source	
<b>Personnel</b> <i>Explain what hourly wage &amp; fringe are based on-- departmental, community or other rate?</i>	Salary = 100_hrs x _\$10_ hrly wage	\$1,000			
	Fringe rate (admin fee @1.25% x salary)	\$12.50			
	Under the direction of the PI, the Undergraduate Project Assistant will be responsible for setting up the workshop website, developing and electronically distributing the homework materials, and photocopying workshop handouts. He or she will attend and take notes at the workshop itself, and post the workshop summary on the				
	<b>Subtotal</b>	<b>\$1,013</b>			
Speaker Honoraria	___ speakers x \$ _____ honorarium				
Supplies & Services	List items and explain use.				
<b>Equipment</b> <i>Equipment costs are allowable only if the justification clearly shows that the equipment is necessary for the project. Include explanation of what will happen to equipment at completion of project.</i>	Identify and explain use.				
<b>Travel</b> <i>Travel costs must include a description of the purpose of the travel, start and stop dates of travel, transportation costs, housing costs, and allowable per diem (use University rates found at <a href="http://travel/umn.edu">http:// travel/umn.edu</a>).</i>	Airfare for 8 US participants @ \$800/person Airfare for 2 European participants @ \$1,400/person Hotel (May 3-4, 2007) for 10 participants @ \$440/person Meals (May 4-5, 2007) for 10 participants @ \$100/person	\$14,600			
	<b>Subtotal research supplies, equipment, travel, other</b>	<b>\$15,613</b>	<b>\$10,000</b>	Graduate School	
<b>TOTAL BUDGET</b>		<b>\$5,613</b>			

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Grant-In-Aid