

Nomination of Drs. Andreas Bommarius and Mark Prausnitz
CETL Innovation in Co-curricular Education Award, 2015

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Professor David Sholl
Chair of the School of Chemical & Biomolecular Engineering
and The Michael E. Tennenbaum Chair and
GRA Eminent Scholar in Energy Sustainability
311 Ferst Drive, N.W.
Atlanta, Georgia 30332-0100 U.S.A.

January 27, 2015

Dear CETL Awards Committee:

It is my pleasure to nominate Professors **Andy Bommarius** and **Mark Prausnitz** for the 2015 CETL Innovation in Co-Curricular Education Award. The basis for my nomination is their work to increase student learning outside the traditional curriculum. They have developed a novel educational experience that gives undergraduate and graduate students an in-depth look into the pharmaceutical industry for five days in Puerto Rico; the course has been offered every year for the last nine years. This unique outside-the-classroom activity brings students in contact with state-of-the-art pharmaceutical manufacturing and industry professionals. Moreover, this experience enriches the course curriculum for all students by integrating the knowledge gained in Puerto Rico into the classroom activities.

To put this activity in context, Drs. Bommarius and Prausnitz teach a classroom-based course on pharmaceuticals (ChBE 4765) every spring semester to undergraduate and graduate students from multiple departments in the Colleges of Sciences and Engineering. This 50-student class is in high demand, often filling within hours after registration opens. The class seeks to provide a highly interdisciplinary education that spans not only the diversity of technical topics important to the development of pharmaceuticals, but also the economic, legal, ethical and other societal issues that shape the field.

In an effort to provide a still richer educational experience, Profs. Bommarius and Prausnitz developed a five-day, intensive visit to pharmaceutical industry manufacturing facilities over spring break; the visit is an optional component of the pharmaceuticals course. It fills every year with the maximum of 24 students, who have visited Amgen, Eli Lilly, Merck, Medtronic, Pfizer, and other leading pharmaceutical companies. These visits include in-depth tours of pharmaceutical manufacturing operations, lectures given by industry scientists and engineers, and direct interactions between students and company professionals.

The plant tour takes place in Puerto Rico, which is one of the world's leading sites for pharmaceutical manufacturing due to tax laws and other considerations. To the best of my knowledge, there is no other educational experience like this offered by any other university. This pharmaceutical industry plant visit is unique in that it brings students up close to more than a dozen different cutting-edge pharmaceutical processes, with the inventors and operators of those processes introducing and explaining them.

A key aspect of the visit is that the technology seen by the students on the plant floor directly relates to the material discussed in the classroom, thereby providing a holistic educational experience. Before the trip, pharmaceutical manufacturing processes are discussed thoroughly in class. Then, when students see the processes in actual plants, they can readily make the connection between course content and real-life manufacturing. After the trip, students make presentations on case studies of real-life pharmaceutical processes and products, many of which are influenced by what the students see on the plant trip. In this way, the experiences and knowledge gained in Puerto Rico benefits the entire class, not just those who were able to make the trip. Finally, because this tour takes place in Puerto Rico, the students experience first-hand the cultural diversity that is such an important part of their field. Visiting Puerto Rico during Spring Break is obviously attractive to our undergraduate students, but it is important to emphasize that this is a program with a strong technical emphasis that greatly enhances the student's learning and understanding of the professional context of the course material they see on campus in Atlanta.

As a final note, Professors Bommarius and Prausnitz have developed and implemented this educational activity themselves and have offered it to students annually since 2006. They do it on their own time as supplemental teaching above and beyond what the School requires (and even go to great efforts to raise money to substantially subsidize the cost of the trip for the students) because they believe it gives students a unique educational experience that is well worth the effort. Both individuals also have very active and well-recognized research programs, so they are not lacking for things to do; their years of commitment to this student-centered program is a clear demonstration of their commitment to this important area.

Summary

I believe this plant trip is an outstanding example of the creativity, leadership, and dedication of two of Georgia Tech's leading educators. It combines real-world training with innovative technology and exposure to cultural diversity outside the classroom as a companion to a structured curriculum in the classroom. I believe that Professors Bommarius and Prausnitz are ideally suited for the CETL Innovation in Co-Curricular Education Award for their excellent and innovative contributions to pharmaceutical education at Georgia Tech.

Sincerely,



David Sholl
Chair, School of Chemical & Biomolecular Engineering
Georgia Institute of Technology

**Plant trip to pharmaceutical industry in Puerto Rico:
Connecting drug design theory with real-world manufacturing processes**

Andy Bommarius and Mark Prausnitz

Objective: Teach students about conventional and innovative pharmaceutical manufacturing through on-site learning at pharmaceutical industry plants with pharmaceutical industry scientists

Intended audience: Senior undergraduate students and graduate students interested in pharmaceuticals

Targeted learning outcomes:

- (1) Students see, hear, smell and, when appropriate, touch a broad variety of real, operating pharmaceutical manufacturing processes.
- (2) Students learn how the manufacturing processes are designed, built, controlled and maintained by industry professionals who operate them.
- (3) Students visit facilities from all sectors of the pharmaceutical industry, including small molecule drugs, biologics, formulation/delivery systems, devices, and supporting operations.
- (4) Students have one-on-one and small-group interactions with industry professionals, as well as with the Georgia Tech faculty leading the trip
- (5) Students learn about pharmaceutical manufacturing while visiting industrial facilities in the context of classroom learning at Georgia Tech.
- (6) Students prepare for the trip through research and presentations about the sites, processes and products they will see and incorporate their learnings from the trip their in-class case-study presentations and reports afterwards.

Approach taken:

In 2006, Drs. Bommarius and Prausnitz introduced a new course on pharmaceuticals entitled “Drug Design, Development and Delivery” targeted at senior undergraduate students and graduate students. The course was innovative in its approach in a number of ways, including teaching an interdisciplinary course with students from Schools in COE and COS, focusing on open-ended questions in a problem-based learning format and addressing the science of pharmaceuticals in the context of the broader impacts on society.

However, Drs. Bommarius and Prausnitz recognized the need to bring students out of the classroom and into the manufacturing plants, offices and labs of the pharmaceutical industry to more fully teach the students how pharmaceuticals are designed and made. Therefore, in 2007, Drs. Bommarius and Prausnitz added to the class an optional five-day visit to cutting-edge pharmaceutical manufacturing plants. The trip took place during spring break and included visits to Amgen, Eli Lilly, Johnson & Johnson, Merck, Pfizer and Wyeth. The trip filled with the maximum of 24 students that year and has been equally successful every year since. Drs. Bommarius and Prausnitz will take students for the ninth

consecutive year during spring break 2015. In every year, the trip has been heavily subsidized using funds raised by Drs. Bommarius and Prausnitz from Georgia Tech and industry sponsors.

The plant trip takes place in Puerto Rico, which is one of the largest sites of pharmaceutical manufacturing in the world due to tax breaks, legal/regulatory issues and other considerations. At each site, students are introduced to plant operations by technical staff through lecture, Q&A and discussion. Then, the students are guided through two different major operations at the site. For example, at Amgen the students have been led through the manufacturing facility of a blockbuster protein drug used in cancer therapy (Neupogen) by the engineer in charge of the process (who is a Georgia Tech alum) and also visit the process R&D facility on site, where Amgen researchers explain the equipment and processes they study. At Merck (hosted by another Georgia Tech alum and former trip participant as a student), the students learn about and see up close the manufacturing process for a new small-molecule diabetes drug (Januvia), as well as for a chewable veterinary product to prevent heartworms (Heartgard). At Johnson & Johnson students have learned about the regulatory issues surrounding the birth control patch (EVRA) and then “gown up” to go inside the manufacturing facility for the patch, as well as the neighboring facility producing birth control pills (Ortho Tri-Cyclen and others). In this way, students gain an in-depth understanding and see real operations for about a dozen different industrial processes covering the range of important pharmaceutical manufacturing activities.

This pharmaceutical industry plant trip is an innovation in co-curricular education in multiple ways. First, it brings students onto the manufacturing floor of leading pharmaceutical companies guided by industry experts who run the facility. There is no other tour like this, in terms of its breadth, depth and quality, in Puerto Rico or anywhere else in the world. Second, the plant trip is conducted in the context of the classroom experience, drawing connections between lectures at Georgia Tech and state-of-the-art processes operating in the plants. The course instructors lead the industry trip every year, thereby fully integrating the classroom with the plant and providing students with close, extended interactions with the faculty in both professional and social contexts.

The classroom experience and the industry plant trip experience are implicitly linked by their common scope of pharmaceuticals. However, there are additional explicit links. For example, there are approximately three weeks devoted to pharmaceutical manufacturing lectures in the class. When the students visit the industry plants, they see the operations in real practice that they learned about in class. There are also about three weeks devoted to lectures on drug delivery systems in the class. On the trip, the students see many of the actual drug delivery systems discussed in class. In addition, when preparing for the trip, all student participants are required to do research on the companies, products and processes that will be examined on the trip and to give presentations to the other students about their findings. After the trip, the class is devoted to student presentations and discussion on aspects of a series of case studies of real pharmaceutical processes and products, many of which the students see on the plant trip. Therefore, the case study presentations and discussions are directly informed and influenced by the experiences on the trip, benefitting not only the students who went on the trip but also those who did not.

Results from Student Survey, 2008-2014

	2008	2009	2010	2011	2012	2013	2014
Demographics							
Undergraduate student ¹	--	54%	48%	59%	61%	56%	88%
Graduate Student ¹	--	36%	39%	32%	30%	44%	8%
Other ¹	--	11%	13%	9%	9%	--	4%
BMED major ¹	--	18%	26%	9%	13%	24%	60%
CHBE major ¹	--	46%	39%	23%	44%	64%	32%
CHEM major ¹	--	32%	22%	36%	35%	4%	8%
Other ¹	--	4%	13%	32%	9%	8%	--
Merck							
Introductory lecture ²	3.9	4.3	4.4	4.5	4.7	3.8	4.1
Heartgard plant tour ²	3.9	4.4	4.6	4.1	4.5	4.2	4.2
Sitagliptin API plant tour ²	3.8	4.3	4.7	4.3	4.8	3.7	4.1
Overall assessment²	4.1	4.5	4.8	4.5	4.8	4.0	4.2
Pfizer							
Introductory lecture ²	3.0	3.2	3.7	3.1	3.1	3.5	3.3
API plant tour ²	4.0	3.9	3.9	3.1	3.6	4.4	4.1
Drug product plant tour ²	4.3	3.8	4.2	3.5	3.8	4.1	3.2
Overall assessment²	3.9	3.8	3.9	3.5	3.6	4.1	3.6
Amgen							
Introductory lecture ²	3.8	3.3	4.3	4.2	--	4.5	4.8
Neupogen plant tour ²	4.4	4.2	4.7	4.5	--	4.4	4.9
Process development tour ²	4.3	3.7	4.6	3.8	--	4.3	4.5
Overall assessment²	4.2	4.1	4.7	4.4	--	4.7	4.9
Wyeth							
Introductory lecture ²	3.2	3.0	--	3.7	3.3	--	--
Zosyn plant tour ²	3.9	--	--	4.0	3.5	--	--
Tygacil plant tour ²	--	3.8	--	3.7	3.7	--	--
Overall assessment²	3.7	3.5	--	3.9	3.5	--	--

	2008	2009	2010	2011	2012	2013	2014
Medtronic							
Introductory lecture ²	--	--	--	3.4	4.0	--	4.7
Insulin pump plant tour ²	--	--	--	3.3	4.5	--	4.7
Reservoir/sensor plant tour	--	--	--	--	4.8	--	4.7
Overall assessment²	--	--	--	3.5	4.8	--	4.9
Johnson & Johnson							
Introductory lecture ²	4.0	2.4	3.4	--	--	--	--
Ortho EVRA plant tour ²	4.0	2.8	3.3	--	--	--	--
Oral contraceptives plant tour ²	4.1	2.9	3.7	--	--	--	--
Overall assessment²	4.1	2.4	3.3	--	--	--	--
Eli Lilly							
Introductory lecture ²	--	--	--	--	4.5	4.1	4.4
Insulin fermentation plant tour ²	--	--	--	--	4.4	4.2	4.4
Insulin purification plant tour ²	--	--	--	--	4.1	4.1	4.1
Overall assessment²	--	--	--	--	4.5	4.1	4.1
Plant tour logistics							
Number of companies visited ³	0.3	0.2	-0.1	0.3	0.1	0.0	0.2
Time spent on plant tours ³	-0.3	0.1	-0.1	0.1	-0.4	-0.4	-0.1
Time spent on lectures ³	0.5	0.3	0.3	0.4	0.4	0.7	0.2
Travel logistics							
Air travel ²	4.0	4.3	4.6	3.9	4.4	4.5	4.7
Bus travel ²	4.2	4.5	4.7	4.1	4.2	4.7	4.8
Hotel accommodations ²	4.1	4.2	4.6	3.7	4.4	4.1	4.6
Overall trip							
Overall assessment of trip²	4.4	4.6	4.9	4.7	4.8	4.6	4.8

¹ Percentage of all participants ² Expressed on a scale of 1 to 5 (where 5 is the best) ³ Expressed on a scale of -2 to +2 (where 0 means the right amount)



19 January 2015

Dear Selection Committee,

It is my pleasure to write this letter to support the nomination of Prof. Mark Prausnitz and Prof. Andreas (Andy) Bommarius for the 2015 CETL Innovation in Co-Curricular Education Award. Mark and Andy have collaborated in the development of ChBE 4765, Drug Design, Development, and Delivery (D4), a course cross-listed with the School of Chemistry and Biochemistry. D4 is quite popular among our student population, and I believe it reached its enrollment limit each year that I have been involved with the course. As a key component of the Center for Drug Design, Development and Delivery's program, D4 also draws from the campus's graduate student population and consistently attracts students from multiple Schools and Colleges.

The D4 course offers the Georgia Tech student an exposure to all the aspects that are behind the introduction of a new, FDA-approved drug to the market. As part of this journey, Mark and Andy introduce students to the fundamental strategies early on during the discovery and design phase of a drug. This task includes exposure to the relevant principles needed to discover a new lead agent, optimize that lead, and elucidate that drug's mechanism of action. To assist in covering these elements, Mark and Andy invite speakers to conduct one or more class sessions. For example, I have contributed material that touches upon discovery and design and Keith Easterling (Emory University, Department of Neuroscience and Behavioral Biology) discusses pharmacological studies that can be utilized to elucidate a drug's mechanism of action. Mark and Andy typically cover material pertaining to pharmaceutical formulation (the mode by which a drug is administered) and to the large-scale production and manufacturing of various types of pharmaceutical agents. During this semester-long course, students learn that the pharmaceutical industry relies heavily on teamwork and is by its very nature multi-disciplinary. For the Georgia Tech students about to enter this workforce, this is valuable insight to possess, as it plants the seed that will enable them to work effectively as part of a team composed of members from a variety of educational and training backgrounds.

Central to the D4 course is a series of student-led case studies that center upon a successful pharmaceutical agent. Several different drugs are chosen for discussion, and each student group focuses on an aspect of the production and formulation of that drug. Collectively, this exercise provides students the opportunity to see how their assigned piece of the process connects to the other components during drug development.

Perhaps the most unique aspect of this course is the option for students to participate in a Spring Break field trip. Each year, Mark and Andy arrange a four-day field trip to Puerto Rico, one of the few regions of the world harboring a high density of pharmaceutical production facilities. Participating students tour multiple production plants, hear presentations from our

School of Chemistry and Biochemistry

Atlanta, Georgia 30332-0400 USA

PHONE 404•385•1154

FAX 404•894•2295

EMAIL wendy.kelly@chemistry.gatech.edu



School of Chemistry and Biochemistry

pharmaceutical production facility hosts, and really see many aspects they learned of earlier that semester in action. I had the privilege of participating in the Plant Tour in March 2012, and was impressed by Mark and Andy's ability to line up top-notch experiences from such companies as Merck, Medtronic, and several others. Additionally, they ensured that students would be exposed to some of Puerto Rico's rich heritage by including a visit to a bioluminescent bay (a very rare natural treasure) and a tour of the some historic sections of San Juan. Ultimately, I think students participating in the Puerto Rico plant tour leave with a clearer understanding of the workings within the pharmaceutical industry and an expanded world view.

In summary, Prof. Mark Prausnitz and Prof. Andy Bommarius are incredibly deserving of the CETL Innovation in Co-Curricular Education Award. They have devoted a great deal of thought, time, and energy into making this course a rewarding experience for their students. The D4 class includes students, faculty, scientists, and engineers from many different academic units on and beyond campus, and helps to prepare future leaders in multiple sectors of the pharmaceutical industry. Georgia Tech is indeed fortunate to have this type of educational experience to offer its students.

Sincerely,

A handwritten signature in black ink that reads "Wendy L. Kelly". The signature is fluid and cursive, with a large, sweeping flourish at the end.

Wendy L. Kelly, R.Ph., Ph.D.
Associate Professor
School of Chemistry and Biochemistry
Georgia Institute of Technology

School of Chemistry and Biochemistry
Atlanta, Georgia 30332-0400 USA
PHONE 404•385•1154
FAX 404•894•2295
EMAIL wendy.kelly@chemistry.gatech.edu

January 22, 2015

Charlene Rincón, Ph.D.
Global Operations Sr. Manager
One Amgen Center Dr.
Thousand Oaks, CA 91320

Dear Ms. Snedeker,

I am writing to recommend Dr. Mark Prausnitz and Dr. Andy Bommarius for the 2015 CETL Innovation in Co-Curricular Education Award. I had the opportunity to plan and coordinate with Dr. Prausnitz and Dr. Bommarius the Drug Design Development and Delivery field trips in 2007 and 2008. Their efforts to make this field trip a reality started in 2006 with planning meetings and a scouting trip to Puerto Rico to establish the different contacts in the biotech and pharmaceutical companies they wanted the students to visit as part of the trip. They wanted to provide the students with a unique and innovative way to see the concepts taught in ChBE 4765 applied to real biotech/pharmaceutical processes and an opportunity to integrate their learnings from the field trip with the course curriculum. It was with tremendous enthusiasm and dedication that the professors built a creative way of teaching the students, through a co-curricular outside the classroom learning experience, the current processes and challenges of the biotech and pharmaceutical industries. The students participating in the trip had to prepare a short presentation of the companies they were going to visit. This requirement provided the students participating in the trip and those who didn't an opportunity to learn more and increase their interest in the processes and companies that were part of the field trip. The field trip not only exposed the students to real life demonstrations of what they learned in the classroom but also provided them exposure to potential future employers. A resume book was prepared for each trip and provided to the host companies. After the trip, the professors asked the students to fill out a survey that measured the effectiveness of the trip in expanding their learning. It also allowed the students to provide feedback on ways future trips could be improved. The surveys I had the opportunity to review were always positively rated showing the students really valued the unique opportunity of experiencing real life demonstrations of the concepts they learned in the classroom.

The innovative, co-curricular, and creative approach to teaching shared by both Dr. Prausnitz and Dr. Bommarius, as well as their effort to expand the horizons of the typical Georgia Tech experience to include a field trip, makes them both excellent candidates for this award. Please feel free to contact me if you have any questions or would like any additional information.

Sincerely,



Charlene Rincón

Jeffrey Gaulding, PhD
5258 Fox Hill Ct, Peachtree Corners, GA 30092
jeffgaulding@gmail.com
678-995-5629

January 16, 2015

Dear Award Committee:

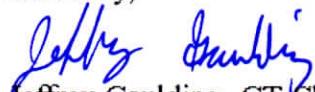
I am writing to express my enthusiastic support for Dr. Mark Prausnitz and Dr. Andy Bommarius for the 2015 CETL Innovation in Co-Curricular Education Award. Their efforts in establishing the Drug Design, Development, and Delivery program have created a rich opportunity for students in a range of science and engineering disciplines to gain a comprehensive appreciation of the multi-faceted challenges unique to the pharmaceutical industry.

I graduated with my PhD in Chemistry in 2013, and I am currently a Senior Research Scientist at 4P Therapeutics – a startup focused on transdermal drug delivery. While at Georgia Tech, I took the ChBE 6765 course: Drug Design, Development, and Delivery (D4) as well as accompanied Drs. Prausnitz and Bommarius and a group of graduate and undergraduate students to Puerto Rico. The D4 class represents an innovative approach to teaching a complex topic that spans many disciplines. Visiting lecturers, complementing Dr. Prausnitz's and Dr. Bommarius's considerable expertise, ensured that each module of the course was taught by specialists and also provided fresh perspectives. Additionally, the students formed interdisciplinary teams (mixing graduates and undergraduates, and students from different majors), whereupon we were given research problems that addressed real-world problems in drug design, development, or delivery. This project required us to apply knowledge from the curriculum, then demonstrate mastery of the multi-disciplinary content through presentations.

A unique opportunity for the D4 class (and open to researchers from other departments as well) is an annual one-week trip to Puerto Rico, which includes visits to six pharmaceutical and medical device facilities. Each visit was accompanied by presentations from the host company and site tours. Puerto Rico's expansive pharmaceutical facilities allowed us to see everything from benchtop research to bulk manufacturing to medical device assembly and packaging. The opportunity to speak with the scientists and engineers who focus on the practical application of the course content was an experience that influenced my own career choices. Dozens of students each year greatly benefit from this firsthand exposure to the pharmaceutical industry and consequently are better equipped to lead the next generation of pharmaceutical research.

With the Drug Design, Development, and Delivery program, Dr. Prausnitz and Dr. Bommarius have developed a unique opportunity for many Georgia Tech students. This program complements and greatly enhances the educational experience for students in any discipline who have an interest in pharmaceuticals. Their achievements with the D4 program make Dr. Prausnitz and Dr. Bommarius an excellent choice for the 2015 CETL Innovation in Co-Curricular Education Award.

Sincerely,



Jeffrey Gaulding, GT Chem PhD 2013

To the CETL Awards Committee,

Jan 30, 2015

I am writing to support the nomination of Dr. Mark Prausnitz and Dr. Andreas Bommarius for the 2015 CETL Innovation in Co-Curricular Education Award, based on their work in designing and teaching ChBE 4765: Drug Design, Development, and Delivery.

I had the privilege of taking this course during the spring of 2014, the final semester of my senior year. I had met Dr. Prausnitz several years before as the professor of my first chemical engineering class. I was immediately attracted to his hands-on teaching style; there are not many classes where you build a catapult! With many such positive experiences in mind, I knew Dr. Prausnitz would bring the same energy and enthusiasm to the end of my undergraduate career.

The highlight of ChBE 4765 is the international trip to Puerto Rico. Seeing the inner workings of one of the most important industries of our time was a once-in-a-lifetime opportunity. Many of us were moving towards pharmaceuticals as our career or field of research, and we were able to appreciate how everything we were learning was implemented in industry on both small and enormous scales. One unexpected bonus was hearing from the employees of both shrinking and expanding companies. Their incredible insights revealed the impact these organizations have on the local communities. Pharmaceuticals compose a large fraction of the Puerto Rican economy, and decisions can ripple far beyond the building where they are made.

Back in the classroom, our projects involved researching specific pharmaceutical products. Everything we had learned helped to illuminate the behaviors of the companies that were researched. There were classroom discussions that wouldn't have been possible otherwise. This was just one of the ways our experiences were tied into the curriculum.

The trip focused on more than the pharmaceutical industry. We were given a personal tour of the Arecibo Observatory by its director, Robert Kerr, and heard first-hand accounts of the extraordinary research being accomplished there. We also kayaked at night through one of the local bioluminescent bays. These bays are one of the rarest and most fragile ecosystems on the planet, and we discussed different preservation initiatives to protect these national landmarks. These activities cannot be replicated in a classroom, and the lessons learned cannot be conveyed through text or speech. They must be experienced, and it takes special individuals to make them a reality.

Through ChBE 4765, Dr. Prausnitz and Dr. Bommarius have made a significant impact on my life and on how I view my place in the world. Georgia Tech is very lucky to have professors of their caliber. I offer my fullest endorsement of their nomination for the CETL Innovation in Co-Curricular Education Award.

Sincerely,

Robert VanDyck

Dear CETL Co-Curricular Education Award Committee:

January 27, 2015

Drs. Bommarius and Prausnitz, through their successful collaborative course ChBE 4765, represent perfect candidates for the Co-Curricular Education Award. It is my understanding that this award is specifically designed to praise faculty members who go above and beyond in their efforts to expose their students to the larger global struggles, obstacles, and achievements in the context of the course. Having taken the course, gone on the optional Puerto Rico industrial plant trip, as well as been a teachers' assistant for the course, I have both reaped the benefits of their collaboration and witnessed the process and planning behind their course. There is more than one aspect that exemplifies the qualifications of this award.

First of all, the class itself is innovative by design. To my knowledge, there are no other classes offered at Georgia Tech that cover such a broad scope of an industry. The class is offered through multiple departments and always contains a mixture of students from different academic backgrounds. The course then covers facets relating to various stages of drug design, development, and delivery. While of course covering the relevant material pertaining to chemistry, biology, patent laws, industry, marketing, and health, this course also addresses the effect all of these developments have on a global scale. A particular lecture that provides an international perspective was a lecture given by Dr. Prausnitz concerning the global attempts at eradicating polio and delivery of the polio vaccine (and other vaccines). By utilizing our acquired knowledge of drug development and delivery, the class held meaningful and enlightened discussions about possible drug delivery techniques appropriate for large scale production, delivery to third world countries, and various obstacles with global medicine. Students were encouraged to innovate solutions to drug distribution and delivery problems at this global scale and increase their own global awareness.

Furthermore, this class also contains a great opportunity for students to extend their learning outside the classroom. Students are encouraged to participate in a class field trip to multiple pharmaceutical plants in Puerto Rico for four days during Spring Break. Large pharmaceutical companies, such as Merck, Pfizer, and Eli Lilly, welcomed a large class of Georgia Tech students into their drug production and processing facilities, giving us invaluable insight into the workings of big pharma. Extended plant tours, presentations catered to students, and discussions with engineers and plant managers allowed for learning and collaborations. We learned about research and development stages, fermentation, production, and packaging in great detail with an interactive experience. Not only did we visit drug companies, but we visited some of the world's leading medical device companies, such as Medtronic, to learn about the production of drug devices and delivery systems. The entire Puerto Rico trip was well planned to include all types of areas in the pharmaceutical field, and I consider the experience invaluable to my education.

As a TA for the course, I've witnessed how both professors consistently stay up to date in an ever evolving field, presenting current events and struggles to the students in a new, thought-provoking manner. They keep in persistent connection with their industrial contacts, often inviting them to come and speak on various topics covered in the class. Drs. Bommarius and Prausnitz deserve the highest praise for their dedication and innovative approach to the subject, and thus are prime candidates for this award. I've enjoyed my experience with both the professors and the course.

Sincerely,

Lindsay Arnold: ChBE Graduate Student

Dear CETL Awards Committee:

January 30, 2015

I'm writing to wholeheartedly nominate Dr. Mark Prausnitz and Dr. Andy Bommarius for the 2015 CETL Innovation in Co-Curricular Education Award. Their work in the design and implementation of the ChBE 4765 Drug Design, Development, and Delivery class has been outstanding and had an immense impact on my undergraduate preparation and on my career selection. Drs. Prausnitz and Bommarius were able to seamlessly integrate all of the different aspects involved in the development of a pharmaceutical which can be extremely complex, all while making the class extremely entertaining, and enjoyable.

Not stopping at the classroom, the ChBE 4765 class gave me the opportunity to travel to Puerto Rico, where along with the rest of my classmates I was able to see all the different topics covered in class, in real life. Visiting some of the world's top pharmaceutical facilities we learned about secret manufacturing processes that only a select group of people in the world is able to see. Furthermore, while attending the tours, we students were able to discuss different processes with the scientists and engineers working in these facilities and understand the reasons why they were performed that way. In this way, we were able to obtain real exposure to what it really means to be an engineer, and how problems are dealt with in the real world.

The trip to Puerto Rico allowed the class to bond as a group, and fostered an environment of collaborations among all students and the instructors. Being abroad while learning about the culture of a different country helped us come together as a group unlike any other class activity could.

After returning to Atlanta, I felt extremely confident about the material that I had learned in the class because I was able to cement the knowledge by exposure to real world applications. This served as incredible support to begin working on the final class project, which required us to apply all the material we had learned. Despite seeming like an impossible task during the first days of the semester, all the hard work we put into the project was extremely enjoyable and fulfilling and seemed to come out naturally.

The experience I had during this class, and getting the opportunity to see all the aspects of creation of a pharmaceutical to the point of commercialization, lead me to seek a career path that would allow me to experience a wide range of activities. At this point I find myself working on my own medical device startup, and following a pathway very similar to the one we learned during this class. To this day I still go back and reflect on the things we learned, and the relationship fostered with Dr. Prausnitz and Dr. Bommarius has allowed me to reach back to them as mentors, share my experiences, and seek their advice.

For these reasons, I am confident that Dr. Mark Prausnitz and Dr. Andy Bommarius are extremely deserving of the 2015 CETL Innovation in Co-Curricular Education Award.

Sincerely,

Jorge Mena

To Whom It May Concern,

It is a privilege to write this recommendation for two outstanding professors, Dr. Prausnitz and Dr. Bommarius. As a student in their class on drug design, development, and discovery, I was given the opportunity to explore a specific field that I had been interested in for years and had yet to be able to study in depth. The class itself was an academic melting pot of engineers, chemists, undergrads and graduate students which led to better development of collaborative skills while offering the chance for intellectual perspectives and challenges outside of one's direct field.

Both professors were not only clear experts on the science that goes into the development of therapeutics and the vast engineering challenges associated with production of such compounds and drug delivery methods, but also the economic and political environment surrounding the business of pharmaceutical industry. Each area was covered in depth and with small contributions from other professors and guest lecturers who served to enhance the exposure to experts in the industry.

In addition, visiting Puerto Rico to tour and experience multiple pharmaceutical companies brought the course to a unique level that cannot be accessed in most classes. Not only was it another opportunity to interact with experts and leaders, but it was a chance to see the inner workings of an industry that is typically very exclusive. At one company, we were able to watch every step in the building of insulin pumps while at another company we witnessed the synthesis of the global yearly supply of a drug. The benefits of such a trip extended past just the technical knowledge gained and into full emersion into Puerto Rican culture, thereby adding a touch of global perspective into a science and engineering education.

Even the format of the course seemed designed to maximize learning and retention of concepts. Each homework and quiz required an increased ability to problem solve using multiple science, engineering, and business concepts. The final project required both scientists and engineering students to come together to find innovation solutions to crucial problems in the pharmaceutical industry and allowed for the use of many of the skills gained throughout the semester.

Simply stated, this was a course unlike any other I had participated in at Georgia Tech. Dr. Prausnitz and Dr. Bommarius should absolutely be awarded the 2015 CETL Innovation in Co-Curricular Education Award.

Sincerely,

Ashley Zuniga

Biochemistry, 2014