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Greetings from the Department Head

Dear Alumni and Friends;

"Commencement" is a funny word. Commencement ceremonies celebrate endings: degrees completed, goals attained, the end of years of study. But the word itself means a beginning, the start of something new. At commencement, we end and begin again - all at once - looking to both the future and the past.

Commencement, in all the richness of its meaning, is part of spring at a university. We hope you'll enjoy some of the IPPH "commencements" that we've assembled for you in this newsletter. At long last, we're ending a four-year renovation of our ground floor laboratories and beginning to move in; check out the photos in this newsletter and online. The accomplishments of our faculty and students are a kind of commencement, too; read about grad student Shweta Raina's work in pharmaceutical solids and Dr. Kinam Park's tumor-on-a-chip. And, of course, we're celebrating with our PhD graduates and former postdocs who are ending their time at Purdue and beginning new phases of their careers.

Lao Tzu reminds us, "Amidst the worldly comings and goings, observe how endings become beginnings." Thanks for checking up on the IPPH endings and beginnings in this newsletter. Hail Purdue!

Liz Topp
Dane O. Kildsig Chair and Department Head



Department Highlights

FACULTY HIGHLIGHTS

- The Purdue University Board of Trustees promoted **Yoon Yeo** to Associate Professor.
- A paper by **Dr. Lynne Taylor** and others has been recognized as one of the ten most downloaded papers in the *Journal of Pharmaceutical Sciences* for the first quarter of 2013. The paper, entitled "Crystallization of Amorphous Solid Dispersions of Resveratrol during Preparation and Storage - Impact of Different Polymers" (*Journal of Pharmaceutical Sciences* 2013 Jan;102(1):171-84), was co-authored by IPPH graduate student **Lindsay Wegiel**, Dr. Lisa Mauer (Purdue, Food Science) and Dr. Kevin Edgar (Virginia Tech).
- **Dr. Stephen Byrn's** proposal entitled "Synthesis, Characterization and Properties of Fast Acting Amorphous Drugs" has received funding from Argonne National Labs, to support his work on acoustically levitated drops.
- **Dr. Rodolfo Pinal** has been selected as a Bindley Bioscience Center Fellow for the period July 1, 2013 - June 30, 2014. Appointment as a Fellow will provide him with time and resources to work on his Fellows Project, entitled "3D Integrated Pharmaceuticals - Large Area Web Nanomanufacturing Methods and Preliminary Testing".
- **Dr. Stephen Byrn** and Senior Research Scientist **Dr. Daniel Smith** were among 47 faculty and staff recognized at the Purdue Research Foundation's eighth annual Inventors Recognition Reception in April. Their patent is entitled "Pyridines for Treating Injured Mammalian Nerve Tissue".
- **Dr. Lynne Taylor's** and **Dr. James Litster's** work is featured on the cover of the 28 March 2013 issue of *CrystEngComm*. The cover represents their article "Quantitative Analysis of the Inhibitory Effect of HPMC on Felodipine Crystallization Kinetics using Population Balance Modeling" (*CrystEngComm* 2013; 15: 2197-2205), published in that issue. The article was co-authored by Kaoutar Abbou Oucherif and **Shweta Raina**.
- **Dr. Tonglei Li's** NSF proposal entitled "Toward Building a Crystal Structure Prediction Framework" has been awarded a grant to support this research.
- **Dr. Yoon Yeo's** proposal entitled "Development of Nanoparticle Depot for Intraperitoneal Chemotherapy of Ovarian Cancer" has been selected for funding by the Mildred Elizabeth Edmundson Research grant program at Purdue's Global Women's Health Institute.
- **Dr. Lynne Taylor** and co-authors' manuscript entitled "Nonlinear Optical Imaging for Sensitive Detection of Crystals in Bulk Amorphous Powders" (*Journal of Pharmaceutical Sciences* 2012 November; 101(11): 4201-4213) was selected as an "Editors' Pick" for the fourth quarter of 2012. The co-authors are IPPH alumnus **Dr. Umesh Kestur**, current IPPH graduate student **Lindsay Wegiel**, and Duangporn Wanapun, Scott J. Toth and Dr. Garth Simpson, all of Purdue's Department of Chemistry.
- **Dr. Gregory Knipp** and co-authors' manuscript entitled "The Effects of Intra-Laboratory Modifications to Media Composition and Cell Source on the Expression of Pharmaceutically Relevant Transporters and Metabolizing Genes in the Caco-2 Cell Line" (*Journal of Pharmaceutical Sciences* 2012 Oct; 101(10): 3962-3978) was selected as an "Editors' Pick" for the fourth quarter of 2012. The co-authors are IPPH alumni **Dr. Wyatt Roth**, **Dr. David Lindley** and **Dr. Stephen Carl**.

Continued next page

Department Highlights continued

- **Dr. Lynne Taylor** and her co-authors received the AAPS Meritorious Manuscript Award last fall for their paper entitled "Understanding the Behavior of Amorphous Pharmaceutical Systems during Dissolution" (*Pharmaceutical Research* 2010 Apr; 27(4): 608-18). The award was accompanied by a cash prize, which the authors have generously donated to our department to be used to support graduate student travel to a conference. The co-authors are IPPH alumnus **Dr. David Alonzo**, along with Drs. Geoff Zhang, Gao Yi and Deliang Zhou, all of AbbVie.

GRADUATE STUDENT HIGHLIGHTS

- **Lavanya Iyer** (Topp group) presented her research at the Graduate Student Symposium at the AAPS National Biotechnology Conference in May. She received an award from the AAPS based on her submitted abstract entitled "Photolytic Labeling with Mass Spectrometric Analysis to Probe Protein-Matrix Interactions in Lyophilized Solids".
- **Saradha Chandrasekhar** (Topp group) has been awarded a Purdue Research Foundation (PRF) grant for her proposal entitled "Thiol-Disulfide Exchange and Disulfide Scrambling in Peptides Derived from Human Growth Hormone". The award provides partial support for her research for the period June 1, 2013 – May 31, 2014.
- **Bo Sun** (Yeo group) has been awarded a Purdue Research Foundation (PRF) grant for his proposal entitled "Nanoparticle Depot for Intraperitoneal Chemotherapy of Ovarian Cancer". The award provides partial support for his research for the period June 1, 2013 – May 31, 2014.
- **Matthew Jackson** (Taylor group) was selected to receive a pre-doctoral fellowship in pharmaceuticals from the Pharmaceutical Research and Manufacturers of America (PhRMA) Foundation to fund up to two years of his doctoral research.
- **Kevin Boksa** (Pinal group) has received a Lilly Endowment Gift Graduate Research Award for his proposal entitled "Matrix-Assisted Co-Crystallization: A Novel Method of Simultaneous Production and Formulation of Pharmaceutical Co-Crystals".
- **Shweta Raina** (Taylor group) has received a Lilly Endowment Gift Graduate Research Award for her proposal entitled "Optimizing Polymer-Surfactant Combination in the Formulation and Manufacture of Amorphous Solids: Predicting *In Vivo* Performance using Transport Measures".
- **Jainik Panchal** (Topp group) has received a Committee for the Education of Teaching Assistants (CETA) Teaching Award from Purdue University. Jainik was honored at the Annual Celebration of Graduate Student Teaching Excellence in April.

Graduate Student Spotlight: Shweta Raina



Shweta Raina measures a polymer for dissolution.

Shweta Raina's conversation pulsates with enthusiasm for pharmaceutical research. Although she originally wanted to study medicine, her uncle, a clinical pharmacologist at Bristol-Myers Squibb, convinced her that a career in pharmaceutical science was her calling.

Shweta, from Mumbai, India, is a fourth-year student in Dr. Lynne Taylor's lab. She earned her BSpS from the Bombay College of Pharmacy at the University of Mumbai, then decided to come to the U.S. for graduate studies. "I really wanted to be on the cutting edge, and the U.S. was the place to go," she said. She completed a master's in Pharmaceutics and Drug Delivery at Northeastern University in Boston, where she specialized in drug delivery in oncology. Her master's thesis focused on improving drug uptake in mucinous adenocarcinomas by inhibiting type O-glycosylation of mucins. She became interested in molecular biology and protein chemistry during that time, and spent a year at the

Boston Biomedical Research Institute trying to understand spatial relationships between structural elements in a calcium channel receptor called ryanodine (RyR1). Although she enjoyed working with cells, as the deadline for applying to PhD programs drew near she realized that pharmaceuticals was her forte. She decided to return to the preformulation/formulation area with a view toward working in industry.

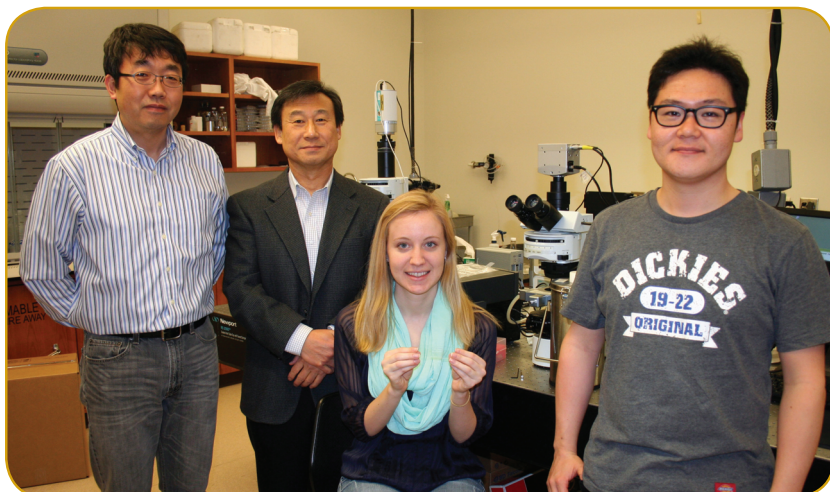
"IPPH is very strong in solid-state chemistry," says Shweta. In Dr. Taylor's lab, Shweta is researching the phase behavior of supersaturated solutions to improve drug uptake and enhance bioavailability. She has interned with Abbott (now AbbVie) in Chicago for two summers. In 2011, she worked on utilizing novel conjugated polymers to inhibit nucleation, and in 2012, she investigated the impact of activity of supersaturated solutions on drug diffusion and drug uptake. She plans to graduate in the spring of 2014, and hopes to stay in the U.S. and work in preformulation/formulation.

"I believe my thesis and work done by colleagues in the past (and future) from the Taylor lab will broaden our understanding of supersaturated solutions generated from amorphous solids and will rescue drugs from the development graveyard," said Shweta.

Along with her enthusiasm for pharmaceutical research, Shweta loves Indian classical dance. She started training in the "Bharat Natyam" classical dance form at age four, and completed "Argangetram," the highest level, when she was in the 8th grade. Bharat Natyam is one of seven different forms of Indian classical dance, focusing on footwork and poses, and is accompanied by narration, classical Indian instruments and vocalists. Shweta would like to dance again when she has more time. She also loves sampling many types of international cuisine, enjoys international films, and is married to Drew Swartz, a doctoral candidate in Mathematics at Purdue.

Research Spotlight: Dr. Kinam Park

Development of Tumor-Microenvironment-On-Chip for Simulation of Complex In Vivo Transport around Tumor



Tumor-Microenvironment-On-Chip (TMOC) Project (l to r): Dr. Bumsoo Han, Dr. Kinam Park, Angela Seawright and Bongseop Kwak

Successful cancer treatment requires effective anticancer drugs as well as their efficient delivery to target tumors. After administration into the blood, anticancer drugs experience multiple levels of complex transport processes to reach the target cancer cells, including blood flow-driven transport of drugs, drug-endothelium interactions, extravasation, interstitial transport and cellular uptake. Because of highly dynamic and complex tumor microenvironments, the *in vivo* efficacy of anticancer drugs cannot be easily tested

using traditional *in vitro* model systems, such as monolayer cell culture. Even xenograft models often fail to simulate human *in vivo* environments and cannot provide mechanistic explanations of the poor *in vivo* efficacy of numerous anticancer drugs and drug delivery systems. Clearly, it is desirable to develop a new versatile model system capable of rapidly and efficiently screening various anticancer drugs and delivery systems for their *in vivo* efficacy. The new model system should also be able to provide mechanical understanding of the critical steps that lead to failures of test drug delivery systems.

Professor Kinam Park, in collaboration with Professor Bumsoo Han in Mechanical Engineering (ME), has been developing a microfluidic device, called Tumor-Microenvironment-On-Chip (TMOC), to simulate the complex *in vivo* transport around the tumor. A schematic of the new 3-dimensional (3D) *in vitro* model system they are developing is shown in Figure 1. The TMOC consists of tumor vasculature, interstitium, and lymphatics, which are critical to the *in vivo* transport of drug. The TMOC is designed to simulate the transport processes around tumors, and provide means to systematically study the impact of each process on the success, or the lack thereof, of drugs and drug delivery systems. Crystal Shin (IPPH), Bongseop Kwak (ME) and Angela Seawright (ME) work on this project.

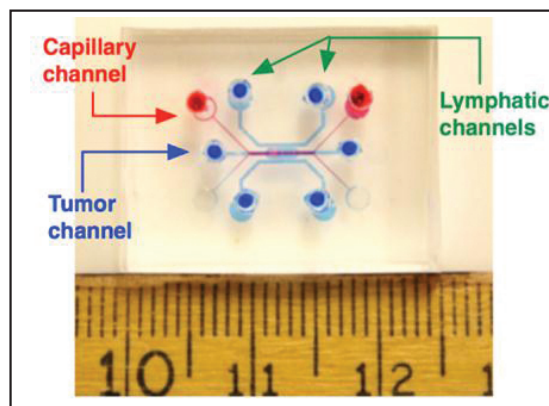
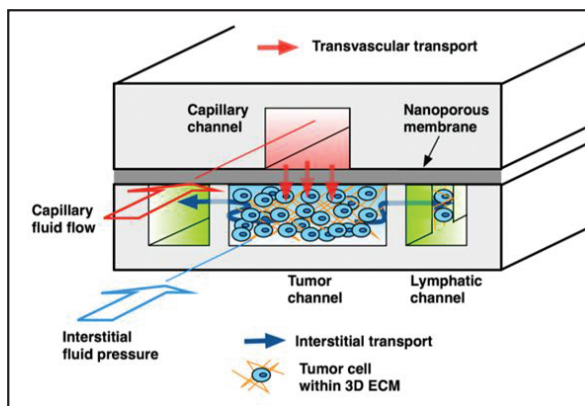


Figure 1. Conceptual design (left) and fabricated prototype (right) of the TMOC. The top channel (red) simulates the capillary with endothelium (nanoporous membrane). Various drug delivery systems can be introduced along this capillary channel. The bottom layer has a center channel (blue) mimicking a 3D tumor microstructure (i.e., cells in 3D matrix) and two side channels simulating the lymphatics (green). The tumor channel is pressurized to establish the elevated interstitial fluid pressure.

**Congratulations,
IPPH Graduates!**

Fall 2012

Yi-Ling Hsieh
Wyatt Roth
Bo Zhou

Spring 2013

Hillary Holback
Grace Ilevbare
Yen Ng

Do you recognize the images?

Page 1 (top) & Page 3 (bottom) - Multicellular tumor spheroids consisting of MCF-7 human breast cancer cells cultured in microwells.

Page 1 (bottom) & Page 2 (top) - MCF-7 human breast cancer cells cultured in flasks.

Page 4 - A multicellular tumor spheroid consisting of GFP-labeled MCF-7 human breast cancer cells.

Editor: DeEtte Starr

Questions or comments? contact starrd@purdue.edu

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Ground Floor Renovations

Phases I and II of the renovation of our ground floor laboratories are finished! After three years of planning and more than a year of construction, the labs and student offices are finally ready. We recently held an open house for the rest of the College; the photo shows a group visiting the new G12. We plan to occupy the renovated labs in July, and research activities will (of course!) begin immediately. We're excited to be offering our pharmaceutical manufacturing course (IPPH 562) in the new manufacturing suite this fall. Visit our website to see photos and videos of the finished project (<http://www.ipph.purdue.edu/renovations/>).

But that's not all. We've received a planning grant from Purdue that will allow us to design renovations for G57 and G59. We're calling this "Phase III" of the overall project.

The planning grant will enable us to accurately define the scope and budget for Phase III. Watch the website for more information as Phase III develops.



Upcoming Events: Peck Symposium 2014

The annual Garnet E. Peck Symposium is now moving to the Spring Semester. IPPH invites you to attend the 11th Annual Garnet E. Peck Symposium on March 7, 2014. The topic will be "Drug Manufacturing," and will be chaired by Professor Tonglei Li. More details TBA. For more information, contact IPPH Communications Coordinator DeEtte Starr at 765-494-1484 or starrd@purdue.edu.