



Leading Research in Biorefining at Lakehead University

Dr. Andrew Dean, Vice-President, Research & Innovation

I am very pleased to welcome you to an introductory newsletter of the Biorefining Research Institute at Lakehead University. This is a very exciting time for BRI. In October of 2014, we hired Dr. Lew Christopher as our new Director. Lew comes to us from the United States and brings extensive knowledge and experience in the research area of Biorefining and administration. Also, last year we hired Dr. Nur Alam as a Lakehead University Research Scientist. Dr. Alam completed his doctorate at Kobe University in Japan and has just finished a 5 year period as a post-doctoral fellow working with Dr. Theo van de Ven at McGill University.

The team of researchers at BRI continues to obtain numerous grants and the total number of graduate students and post-docs at the Institution is now at the level that we are finding space an issue. Collaborations with Industry is at an all-time high and the

BRI is certainly poised to be the center of fundamental research and training of students for the Forestry Industry in Canada in the future. Recently the University partnered with University of New Brunswick to submit an application to the Canada First Research Excellence Fund. Both universities had been invited to submit full applications after their initial letters of intent were successful. The grant application (\$63M and \$42M of leveraged funds) would be used to form The Institute for Forest Product Innovation and would establish Lakehead University and the BRI as one of the leading research institutes in the world in this area. This is a very exciting opportunity and even if we are not successful with our application the connections that we have made with this joint proposal will lead to a number of collaborative projects.

The purpose of the newsletter is to provide the community regular updates on the successes and new endeavours being undertaken at the Institute. The BRI is a key focus of research at Lakehead University and I personally look forward to reading about the accomplishments of the researchers in each forthcoming issue.



Welcome to the Biorefining Institute!

Dr. Lew Christopher, Director, Biorefining Research Institute

I have the pleasure of sharing with you the first edition of our BRI Newsletter. BRI brings together the biorefining knowledge, experience and enthusiasm of a vibrant team of researchers from several departments and programs at Lakehead University that collectively possess the expertise required throughout the entire bioprocessing chain - from feedstock supply and logistics to biomass hydrolysis and fermentation to the final end product recovery. Although the BRI Associate Members come from diverse backgrounds, we all share a common vision for the transformation of our society to a global Bioeconomy that is based on responsible exploitation of our renewable resources and sustainable energy production.

Replacing fossil fuel-based products such as plastics and solvents with biomass-based equivalents has long been a goal of the biobased industry. The vision is a Biorefinery - the equivalent of an oil

refinery-producing many chemicals with hundreds of end uses. The ultimate biomass facility would in many ways resemble an oil refinery with a biomass substitute for petroleum. Today's ethanol plant or a pulp and paper mill can be seen as an early stage Biorefinery. The Biorefinery concept may be inevitable, although the road to a Biorefinery will likely be more evolutionary than revolutionary.

Shifting society's dependence from petroleum-based to renewable biomass-based resources is generally viewed as key to the development of a sustainable industrial society, energy independence, and to the effective management of greenhouse gas emissions. With emerging research trends in the production of bio-based products, the Biorefinery concept will continue to gain momentum. There are major challenges in reducing production costs in Biorefineries posing great opportunities for fundamental science and engineering research. New research may lead to dramatic shifts from the way we currently conceive and practice biomass production and conversion. This is

a challenge and an opportunity that we are currently facing in our transition to a bio-based economy.

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2015 - A YEAR IN REVIEW

for Dr. Sudip Rakshit, BRI Associate

Dr. Sudip Rakshit joined Lakehead University as a Canada Research Chair (Tier 1) in 2012. Prior to arriving at Lakehead University, he served as the VP Research and Professor in Food Engineering and Bioprocess Technology at the Asian Institute of Technology (AIT), Bangkok, Thailand. He had earlier worked in the Chemical Engineering Department of the Indian Institute of Technology (IIT), Madras, India. During his graduate studies at IIT, Delhi, India, a pilot plant to produce 100 litres of absolute alcohol from lignocellulosic residues was set up. This was a culmination of considerable work in pretreatment, enzymatic hydrolysis and fermentation of lignocellulosic biomass.

This past year the designated lab space in the 1294 Balmoral Street building was refurbished and new equipment was installed. This large undertaking / endeavour was made possible by using the funds from Canadian Foundation for Innovation (CFI), Leaders Opportunity Fund and the Ministry of Research and Innovation's Ontario Research Fund grant (ORF).

In order for the lab to become fully operational and for the research to begin on a list of exciting projects, Dr. Rakshit needed to populate it with students. Dr. Rakshit was able to hire two post-doctoral students, two doctoral students, two summer interns and two visiting students in the lab. The multi-cultural background of these students from Brazil, Ethiopia, India, Nepal, Nigeria and Sri Lanka added to the positive atmosphere in the lab. One of the summer interns, Chinomnso Ewelik, won an NSERC - Undergraduate Student Research Award (USRA), for the internship period and a PhD student, Sai Swaroop Dalli, was awarded a MITACS Global Link Research Award for a three month stay in the University of Sao Paulo, Brazil.

Dr. Rakshit, is well-known for his work in bioprocessing in May 2015, he was very excited to be invited to the Canadian House of Commons to serve as a "Witness for the Standing Committee on Natural Resources", Meeting No. 57, on the discussion panel, "Renewal of Canada's Forest Industry". In August, he was invited by the Swedish Research Council for the second time to serve as a panel member to review proposals submitted for funding in the area of bioprocess and environmental technology (NT 17) in Stockholm, Sweden.

Among the funding obtained in the calendar year was an NSERC Discovery Development and an Engage grant with a local food processing industry. He was appointed Distinguished Adjunct Professor at the Asian Institute of Technology (AIT), Bangkok, Thailand. He was instrumental in the creation of an informal Lakehead University Climate Knowledge (LUCK) platform with seed support through

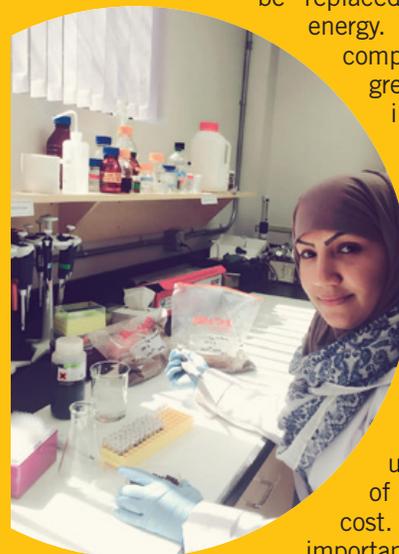
the LU VP-REDI Strategic Team Research grant. Dr. Rakshit also published 5 papers in international referred journals, participated in 5 invited lectures/presentations, and contributed two articles for the local Chronicle Journal

Congratulations Dr. Rakshit on a successful and busy year!

Increased Production of Cellulosic Sugars from Lignocellulosic Materials through Enzyme and Pulp Recycling

Alaa Alhammad, MSc Student, Biotechnology

Due to increasing demand of energy and production of greenhouse gases, currently dominant fossil fuels will be replaced by clean, renewable energy. Lignocellulose is non-competing with food and has great potential in developing biofuels but it is still



a challenge to break-down lignocellulose to release fermentable sugars, the intermediate product for different biofuels and biochemicals. Pretreatment and enzymatic hydrolysis of lignocellulose for generation of sugars usually count for 40% of bioethanol production cost. Thus it is economically important to fully utilize the lignocellulosic substrate and enzymes

in hydrolysis. My project is about developing a novel process for enzymatic hydrolysis of lignocellulose for sugar production. In this process, I will separate lignocellulosic residues, enzymes and sugars after enzymatic hydrolysis, and reuse the residues and enzymes in the hydrolysis process. Combined with the unique pretreatment process to breakdown wood chips to cellulosic fibers developed by our industrial partner, the proposed technology I am working on may have great impact on reducing the overall cost for value added production.

Good luck on your future endeavors Alaa!

Good News Stories from 2015



Dr. Aicheng Chen, Professor/Canada Research Chair, Chemistry received the 2015 Lakehead University Building Research Capacity Award, which is presented to an individual or a group of researchers who significantly enhanced Lakehead University's research capacity beyond their personal program of research. In addition, he was awarded the

2015 RBC Innovation Award - Innovative Hero of the Year, which recognizes an individual in Northwestern Ontario who takes an innovative approach to improve his / her organization, business, or community. *Congratulations Dr. Chen on these prestigious awards.*



Dr. Mathew Leitch, Associate Professor, Natural Resources Management and his associates/group/students received Knowledge Transfer & Tool Development grant (KTTD) from the Forestry Futures Trust program. This grant has allowed Dr. Leitch to prove that his system of whole tree mapping could be used to enhance the provincial Forest Resource Inventory (FRI).

This system could assist industry and planners to manage their resources, assess where the different wood qualities are across the landscape and also help in the labeling of lumber grade maps. Essentially this means the group has developed a method of non-destructively mapping trees physical and mechanical properties, from pith to bark and base to crown of the tree. This system could apply to individual trees as well as stands and whole landscapes.

This method will also allow industry to react quicker to market demand and for the province and economic development planners to better promote their forest resources to new investment, particularly for value-added companies who have stricter requirements for wood they use for their products.

This system is currently being tested on a 100,000 ha block on the Dog-Mat forest west of Thunder Bay. The group completed half of the field work during the summer of 2015, the next half to be completed this summer. If the Ministry of Natural Resources and Forestry and Forest Resource Inventory committee find our results to be positive, the system can then become integrated into the "enhanced" Forest Resource Inventory (eFRI) system for all Ontario forest inventory activities. *Keep up the great work, Dr. Leitch and team!!!*



Dr. Pedram Fatehi, Associate Professor, Chemical Engineering and Canada Research Chair in Green Chemicals and Processes. Dr. Fatehi's current project is entitled "Creating Greener Processes in the Pulping, Oil, and Mining Industries". Two main questions he will be looking to answer are; how can the Canadian pulp and paper industry compete better globally? And how can our

mining and oil industries be more environmentally friendly without increasing costs? Dr. Fatehi and his research team are working with industry and academic researchers to come up with ways to produce chemicals that will create greener, more cost-effective pulping, mining and oil processes. Currently, the mining and oil industries use oil-based chemicals to improve efficiency in their processes. But these chemicals are usually both expensive and toxic. Fatehi and his research team are exploring whether part of the biomass currently wasted in pulping processes could be harnessed to improve process efficiency in the mining and oil industries, as well as in waste-water treatment systems. Dr. Fatehi hopes to develop feasible, environmentally friendly processes for producing these green chemicals, and to find uses for them in the mining industry, oil-sand mixtures, tailings ponds and waste-water treatment systems. *Wishing you Good Luck Dr. Fatehi, we are looking forward to your findings!*

My experience in Brazil, as a Mitacs Globalink Researcher



Being a doctoral student at BRI, Lakehead University, I have got an opportunity to do research in "Biorefining" and "clean energy", one of the major problems in the current times. My research, involves producing value added chemicals and fuels from a renewable wood resource. The research in this field has gained attention globally and as a result I have been awarded

"Mitacs Globalink Research Award" and got supported by Mitacs to pursue a short term (4 months) research in Brazil at one of the esteemed institutions, "University of Sao Paulo". I am delighted to receive this prestigious award and glad to work with world renowned scientists in the field of my research. This short term research has led to collaboration between both the research groups at Lakehead University, Canada and University of Sao Paulo, Brazil.

I had a great diverse experiences in the research, culture and tradition. Brazil is certainly a touristic place and I have not missed the opportunity to explore the cities and beaches, like everyone does. One of my great experiences include my visit to southern Brazil, where we experience wonderful weather and beautiful beaches. The first thing that surprised me about Brazil is the use of 100% Ethanol in vehicles. I am aware that blended gasoline is more common in many countries, but I barely knew about the usage of pure ethanol in the "flex-fuel automobiles", which means either gasoline or ethanol can be used in the same engine. The government is encouraging people to choose ethanol over gasoline by keeping the price lower than petroleum fuels. Being a "Biorefining researcher", this kind of stuff inspires me to do better research to follow more alternate greener approaches for fossil fuel supplies.

*Submitted by: Sai Swaroop
Dalli, Doctoral student.*



Enzo Monte Canedo Brazilian Internship Student

My name is Enzo Monte Canedo and I am a Brazilian internship student from Federal University of São Carlos. After securing funding for my internship through the São Paulo Research Foundation (FAPESP) and accepting the intern offer from Dr. Lew Christopher in the fall of 2015, I arrived in Thunder Bay, Ontario to do part of my PhD project at Lakehead University's Biorefining Research Institute (BRI). My stay in Thunder Bay started in January 2016 and will be completed in July 2016.

My PhD project is focused primary on the biotechnological exploration of a particular *Mucorales* strain. While working in the labs at the BRI, I have been developing experiments on lipid production and the screening of several different *Mucorales* strains along with other products, such as ethanol and other small molecules of interest. I have also been using different organic biomass, such as primary sludge and poplar pulp for the cultivations.

My experience in Thunder Bay has been fantastic. Lakehead University hosts many international students from all of the world. During my stay, I have learned about other cultures, learned new languages and enjoyed tasting incredible new foods



as well as sharing my own Brazilian culture and experiences. I will very much miss the people that I have worked with during my stay in Thunder Bay, as each person has made this experience unique for me. I will also miss the food which I have tasted, the Arabic and Chinese were very good, but the Poutine was delicious, so much so, I have learned how to make it so I am able to share with my Brazilian friends and family.

I would like to thank FAPESP for giving me this scholarship and this opportunity to improve as a scientist and as a person. I also thank my supervisors, Drs. Edson Rodrigues Filho and Lew Christopher for giving me all their support during this internship. I believe that this experience at the BRI has improved my research with all expertise and structure which the BRI offers.

Recent News



Lew addressing the International Pulp and Paper Congress delegates in Sao Paulo, October, 2015

Dr. Lew Christopher has recently obtained two major grants from federal sources: an NSERC Discovery grant for a total of \$135,000 over a period of 5 years, and a CFI Equipment grant that amounts to \$148,847. In response to the call from the Canadian forest industry for the next generation of 'employment-ready' Highly Qualified Personnel (HQP), he has recently led the preparation and submission of an interdisciplinary and interinstitutional CREATE proposal that aims to establish a unique and highly specialized training program for undergraduates, Master's and PhD students at both Lakehead University and the University of New Brunswick (UNB), as the education component of the recently submitted CFREF research initiative between the two universities.

In August 2015, Dr. Christopher chaired the "International Biotechnology Congress" held in Birmingham, UK. He was also invited to present one of the keynote lectures at the "48th Pulp and Paper International Congress Expo" held in Sao Paulo in October last year. In 2015, he served as a Member of the Organizing Committees of the "International Congress and Expo on Biofuels & Bioenergy in Valencia, Spain and the PAPTAC's "International Forest Biorefinery Summit" in Montreal.



Welcome to the BRI Dr. Nur Alam!

Dr. Nur Alam was recently appointed as an Assistant Research Professor at the Biorefinery Research Institute (BRI) at Lakehead University in Thunder Bay. Previously he was a Research

Associate in the Department of Chemistry at McGill University under the supervision of Prof. van de Ven and actively involved in the project of "chemical modification of cellulose fibers." While at McGill he published 12 papers on cellulose chemistry and produced 2 patents. He is a co-inventor of novel fibres that can take up water 500 times its weight, and are suitable for certain applications like diapers/personal hygiene product, wiping papers and biomedical applications. He clearly is an excellent and creative experimental chemist with an profound knowledge of cellulose chemistry.

Presently here at BRI, he is actively involved in the project of "Production and application of highly-reactive bio-based polymers with novel properties and unique functionalities."

SAVE THE DATE

International Forest Biorefining Conference - IFBC

May 10-12, 2017

Thunder Bay, Ontario



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