Volume VI Number 1 Winter 2009/10
OFFICIAL PUBLICATION OF THE ADVANCED FOODS AND MATERIALS NETWORK

ADVANCE

Français au verso

Hold the salt!

Prof. Dérick Rousseau may have a solution for Canada's salt obsession. See page 17.

INSIDE:

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ADVANCE

Volume VI Number 1 Winter 2009/2010

The official publication of the Advanced Foods and Materials Network

A publication to promote dialogue and understanding about sophisticated foods and materials research across Canada

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ADVANCED FOODS & MATERIALS NETWORK
Inspiration from the ground up. | Aux racines de l'inspiration.

Welcome

Welcome to the sixth annual edition of *Advance*, the official publication of the Advanced Foods and Materials Network (AFMNet).

In the five years since our first edition, AFMNet has become a leader in multidisciplinary research on novel foods and bio-materials. Our researchers and their talented teams of students have made discoveries that are helping to shape public policy, improve the health of Canadians and provide the foundation for new businesses.

In this issue, you will find out how Rotimi Aluko's pea peptides can be used to prevent hypertension and kidney disease; how Yoshinori Mine's egg-yolk-derived peptides can reduce gut inflammation; and how Spencer Henson and John Cranfield's insights into Canadian consumers' attitudes on functional foods, nutraceutical products and food labels can shape public policy.

This issue also highlights new areas of research. Stephen Cunnane and Melanie Plourde are studying whether fish oil can reduce the risk of cognitive decline and Alzheimer's disease. Dérick Rousseau is finding new ways to reduce salt consumption, by devising strategies to reduce the salt content in foods and to modify the physical components in salt that are harmful to our health. And David Kitts is developing safer folate supplements using micro-encapsulation technology that could be beneficial to pregnant women.

We hope that you enjoy reading this issue, and that it contributes to your understanding of the significant progress the AFM Network has achieved in meeting its goal of creating benefits for Canadians. Your feedback is welcome and appreciated as always.

Sincerely,

Dr. Larry Milligan
Chair of the Board of Directors, AFMNet

Dr. Rickey Yada
Scientific Director, AFMNet

Dr. Larry Milligan

Chair of the Board of Directors, AFMNet

Dr. Rickey Yada

Scientific Director, AFMNet

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SPARK 20 YEARS

The salt-reduction message in this issue's cover story prompted SPARK contributors to be photographed with their favourite non-salty snack.

All contributors to *Advance* are part of Students Promoting Awareness of Research Knowledge (SPARK) at the University of Guelph. SPARK's mandate is to write and broadcast research in ways that are relevant to the public. In 2009-2010, SPARK is celebrating 20 years of research writing, photography, videography and production.

Joey Sabljic

A second-year English student and self-proclaimed gourmand, Joey Sabljic was raised in Guelph, Ontario, on a diet consisting mostly of his Nonna's home-cooked, Italian cuisine. Now, with new, enhanced food products on the market, researchers can use the AFMNet Consumer Monitor to determine if people are embracing new foods. Read about it on page 12.

Natalie Osborne

Second-year biomedical science student Natalie Osborne of Guelph, Ontario has a keen interest in medical advances. So she was eager to write about a new way of packaging folate, an essential vitamin, which may be key in solving neurological conditions such as spina bifida. Find out more about this new technology on page 20.

Andra Zommers

Andra Zommers, a fourth-year international development student from Hamilton, Ontario has travelled as far as Southeast Asia where she absorbed local culture and sampled many kinds of fish. Her story in this edition of Advance examines the different ways people metabolize fish oils and the fish-human health connection. See her story on page 8.

Photo by Dave Peleschak

Anupriya Dewan has a special interest in health-related research stemming from the knowledge she gained in her nutrition and nutraceutical science undergraduate degree. Now a first-year graduate student in naturopathic medicine, this Brampton, Ontario native immersed herself in new research findings about genetics and vitamin C deficiencies. See page 24.

Anupriya Dewan

To Carol Moore, a fifth-year animal science major from Sussex, New Brunswick, snacking on something sweet is a welcome break from her hectic school and work schedule. That's why she was excited to find out that a University of Guelph researcher is developing a trans-fat-free fat substitute for use in baked goods. You'll find her story on page 16.

Carol Moore

Fifth-year English student Katelyn Peer from Waterdown, Ontario knows how important it is to eat healthily when she's hitting the books or the volleyball court. Since eggs are one of Katelyn's favourite foods, she was excited to learn that researchers are finding ways to use their wholesome peptides to improve gut health. Read about these new developments on page 13.

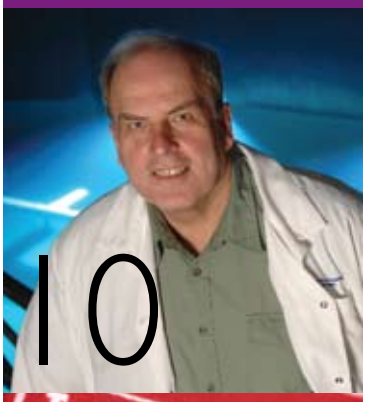
Katelyn Peer

Johnny Roberts, a third-year theatre studies student, has always tried to eat a healthy diet full of fruits and vegetables, and low in salt. However, many Canadians inadvertently consume excess salt in processed foods daily… without even knowing it. This Chatham, Ontario native writes about research aiming to reduce salt in specific processed foods on page 17.

Johnny Roberts

Third-year psychology co-op student Vanessa Perkins from Newmarket, Ontario considered pursuing photography before coming to Guelph. Now she has the best of both worlds, as this issue's photo co-ordinator. She also collaborated on a story about what flaxseed can do when introduced into a balanced diet. See page 21.

Vanessa Perkins



ADVANCE

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James Brylowski

Be a Food Researcher for a Week

Opening doors for aspiring scientists

AFMNet's Be a Food Researcher for a Week program brought Lindsay Bristow (left) and Shyanne Kinnowatner to Prof. Ahmed El-Sohemy's lab.

By Louise Jessup

It's not every day aspiring young scientists – especially those from under-represented and remote communities – get to spend time with leading researchers on the cutting edge of new advances in food science and nutrition. But that's now possible through AFMNet's inaugural *Be a Food Researcher for a Week* program, designed to bring together gifted high school students with network members.

The program is designed for First Nations, Métis and Inuit students in grades 11 and 12 with an aptitude for science or social science, and an interest in the food science and nutrition fields. The Canadian government has recognized that Aboriginal students are under-represented in university-level sciences, and supports this program as a means to spark their interest in science-related studies and professions.

After an application process, 12 Aboriginal high school students from Ontario, Quebec, Manitoba, Saskatchewan, Alberta, the Northwest Territories and Nunavut were selected to participate. They spent their spring break in university labs country-wide, getting a glimpse of researchers in their working environment.

Lindsay Bristow from Winnipeg and Shyanne Kinnowatner from Nunavut were in Prof. Ahmed El-Sohemy's nutrigenomics lab at the University of Toronto. There, they learned lab techniques, such as DNA isolation and genotyping, as well as how to collect samples. The students also toured the University of Toronto campus and saw the food production and development labs at George Brown College where they met Chef David Wolfman from the TV show *Cooking with the Wolfman* on the Aboriginal Peoples Television Network.

"Taking part in the *Be a Food Researcher for a Week* program was truly one of the most enlightening experiences of my life. The trip opened my eyes to different universities and to the various fields and occupations available to individuals through nutrition research," said Bristow.

The *Be a Food Researcher for a Week* program is supported by Dr. Verna Kirkness, a member of the Order of Canada and a lifelong advocate of Aboriginal education.

"Education is the key to the future of our young Aboriginal people," she says. "An opportunity to be a food researcher for a week is an exciting and meaningful connection to the broad world of science. As the program continues, it will motivate our youth to consider science as an inspiring field of study." ●

Can fish really reduce the risk?

Linking Alzheimer's disease to omega-3 degradation in ApoE4 carriers

By Andra Zommers

As the population ages, the merits of fish oils and the important omega-3 fatty acids they contain are being revisited. Foods rich in omega-3s have become increasingly popular with consumers for their various health benefits, with some evidence supporting their ability to reduce the risk of cognitive decline and Alzheimer's disease.

However, researchers at the Université de Sherbrooke in Quebec say these omega-3 fatty acids are far from being a universal cure-all. Some people, they say, may benefit more from omega-3s than others.

According to Prof. Stephen Cunnane and Dr. Melanie Plourde, Department of Medicine, the genetic encoding of the cholesterol regulator in the blood called Apolipoprotein E (ApoE) may be important to understanding how the body incorporates omega-3s.

The researchers conducted pilot studies that show people carrying the isoform ApoE4 may not metabolize omega-3 fatty acids the same way as those carrying the other ApoE isoforms, E2 and E3. This may explain the higher risk of cognitive decline associated with those carrying the ApoE4 lipoprotein. Indeed, ApoE4 carriers have the highest known genetic risk for Alzheimer's disease. Approximately half of all Alzheimer's cases are ApoE4 carriers – about double the percentage in the general public.

"If you eat fish, normally the elderly have a somewhat lower risk of cognitive decline," explains Plourde. "But if you're an ApoE4 carrier and you eat fish, you're not protected against this risk."

For the 20 to 25 per cent of Canadians who carry the ApoE4 gene, this finding could have implications for their dietary and lifestyle choices.

To further explore the link between ApoE4 and Alzheimer's disease, Cunnane and Plourde are monitoring equal numbers of carriers and non-carriers of ApoE4, all diagnosed with mild cognitive impairment, in a six-month study under way now.

Participants in this study are being given a tracer form of docosahexaenoic acid (DHA), which follows omega-3 molecules

Michel Caron

M.Sc. student Milène Vandal is testing omega-3 fatty acids to help determine which genes utilize them the best to protect against Alzheimer's.

through the bloodstream and traces their degradation as they're metabolized. Each group will also receive omega-3 fatty acid supplement capsules.

The researchers hope this study will help bridge one of the knowledge gaps in the understanding of nutritional links to cognitive decline. It should also help focus public health and clinical intervention strategies involving fish oils, they say.

"We believe it's the first time that a group will have tried to differentiate people with mild cognitive impairment according to omega-3 status and ApoE genotype," says Plourde. "If we can understand why there's an apparent alteration in the metabolism of omega-3 in ApoE4 carriers, we may be able to target treatment better."

The researchers point out that ApoE4 genotyping is not a diagnostic tool, nor is there any treatment or preventive strategy linked to the ApoE lipoprotein. Genotyping can, however, indicate a statistically higher risk or greater likelihood of contracting Alzheimer's disease.

That's not to say there's nothing to be done to decrease the chances of cognitive decline. There are risks, considered to be modifiable, that can be actively managed through healthy lifestyle choices. According to Cunnane, adult onset diabetes remains the most significant of these modifiable risks for Alzheimer's disease.

"There are some nutritional advantages that some populations seem to have when it comes to Alzheimer's disease, and that includes higher fish intake," he says. "But the main thing you can do to take care of yourself and reduce your risk of getting Alzheimer's is to avoid adult-onset diabetes. You can go from a semi-diabetic state to a non-diabetic state in less than a month, so it is possible to modify this risk."

This study is being conducted in collaboration with Laval University, Cornell University and the National Research Council.

Funding is provided by AFMNet, the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council, the Canada Foundation for Innovation, Canada Research Chairs Secretariat, Department of Medicine at the Université de Sherbrooke, Fonds de la Recherche en Santé Québec and the Research Centre on Aging at the Université de Sherbrooke. ●

Promising peptides

Fish peptides and genetics could spark unique disease treatment

By Carol Moore

Diabetes, obesity and cardiovascular disease (CVD) are three of Canada's major public health problems. Studies have found fish proteins have the potential to prevent these epidemics from escalating. Now, a group of researchers from across Canada is going one step further. They're collaborating to identify specific fish peptides that will reduce the prevalence of these diseases and allow for more personalized treatment.

Prof. André Marette, a faculty member in the Department of Medicine at Laval University and the scientific director of Laval's Institute of Nutraceuticals and Functional Foods (INAF), will be working with Prof. Tom Gill from the Canadian Institute of Fisheries Technology at Dalhousie University to use specific fish peptides to improve insulin resistance and reduce inflammation – the known causes of diabetes and CVD.

With Prof. Marie-Claude Vohl of Laval's Department of Nutrition and INAF, they're also trying to identify certain genes affected by the diseases and specific genes that react to treatment from the peptide. This means patients could receive more personalized and focused treatment.

"This study is a logical progression from previous ones that have shown that fish proteins improve insulin sensitivity and reduce metabolic complications related to insulin resistance," says Marette.

The researchers will be screening fish proteins and peptides, looking for biological activity on cell culture models –

Continued on page 10

Continued from page 9

myocytes, adipocytes and endothelial cells – that are representative of the tissues known to be affected by obesity, diabetes and CVD. This will help them see which peptides actively reduce inflammation within certain cells. Once the proteins are screened and the peptides are identified, they will be tested in pre-clinical trials on animal models (mice) in collaboration with Prof. Roger McLeod at Dalhousie University.

The goal of the pre-clinical trials is to see which peptides will work *in vivo*. This will give researchers a good idea of how the peptides would affect humans and the potential for treating obesity-linked diabetes and CVD. These clinical trials and consumer studies will be carried out by Dr. John Weisnagel and Prof. Hélène Jacques from Laval University, in collaboration with Profs. Bruce Holub and Spencer Henson at the University of Guelph, and Dr. Jiri Frohlich at the University of British Columbia.

Incorporating assorted sciences into this study will provide a wide-ranging assessment of how the peptides will affect human health. Through genetic screening, specific genes can be identified as they're affected by a disease. If the diseased gene responds to treatment from the peptide, it could indicate that more targeted, personalized disease treatment is possible.

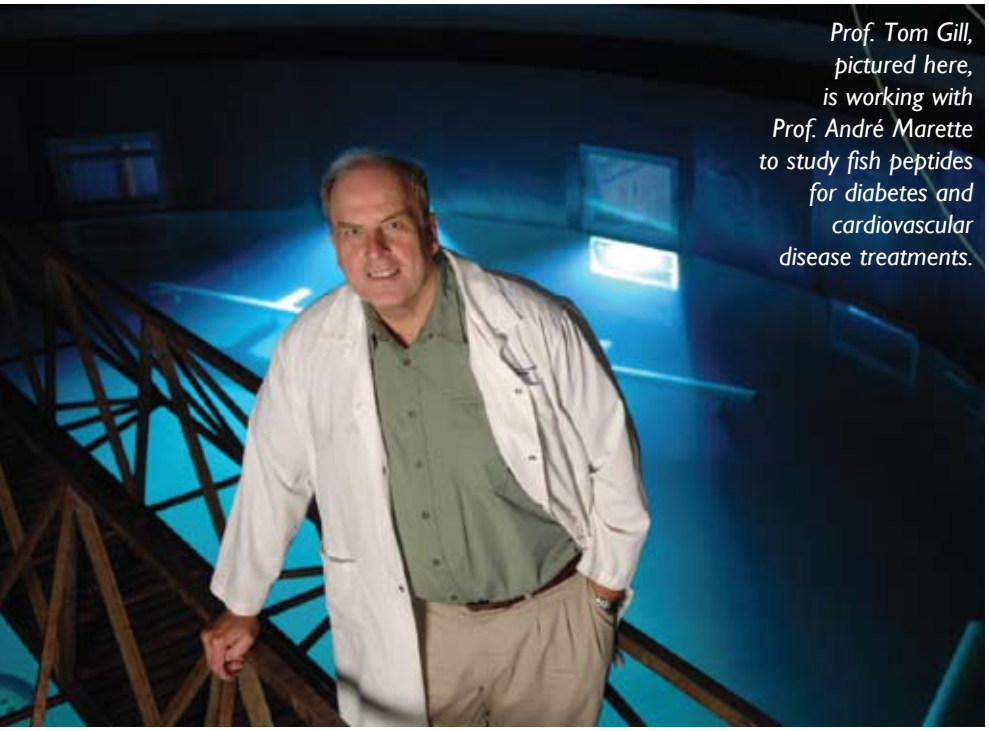
A range of fish species will be examined to see how peptides from different species affect cells. Some species' proteins may work on one aspect of cardio-metabolic syndrome and not another, which could lead to a range of fish products designed specifically to treat certain conditions.

"This will lead to more personalized nutritional recommendations," says Marette. "This study could also generate a new variety of nutraceuticals."

The plan is to incorporate the identified fish peptides into functional foods in collaboration with Prof. Allan Paulson at Dalhousie University and Prof. Dérick Rousseau at Ryerson University.

Some inconsistencies could still arise when assessing these peptides, because individuals react differently. However, the objective of the clinical trials is to get a good representation of the Canadian population that would validate health claims made by the food industry regarding how fish peptides work to reduce obesity, diabetes and CVD.

Funding for this project is provided by AFMNet, the Canadian Institute of Health Research, the Canadian Diabetes Association, the Canada Foundation for Innovation and the Natural Sciences and Engineering Research Council's Strategic Fisheries Grant Program. ●



Prof. Tom Gill, pictured here, is working with Prof. André Marette to study fish peptides for diabetes and cardiovascular disease treatments.

Danny Abriel

From the ocean: a new source of fibre

By Andra Zommers

Petrochemical-based products surround consumers daily, from garbage bags to toothpaste tubes. But mounting public concern over the world's depleting crude oil reserves has uncovered the need for new, renewable sources of high-performance materials. According to a University of Guelph research team, one solution lies with the ocean-dwelling hagfish – or rather, its slime.

The team, led by Prof. Douglas Fudge, Department of Integrative Biology, has discovered that the protein fibres in hagfish slime can be transformed into amazingly versatile threads. They're more stretchable than the synthetic material Kevlar, and about as strong as spider silk – one of the strongest materials known.

Hagfish naturally produce fibrous slime as a defense mechanism. When provoked by predators, they secrete small amounts of the slime, which reacts with salt water to expand into a large cocoon that deters the predator.

To turn the fibres into silk-like threads, they're stretched in water and then dried out. This makes them capable of absorbing huge amounts of energy before breaking.

Fudge says hagfish slime has the potential to replace conventional petrochemical-based materials, such as nylon, polyethylene and polypropylene, which comprise two-thirds of the industrial fibre market.

"Eventually petroleum's going to run out, or get really expensive," says Fudge. "If we can develop a material that can actually help wean ourselves off petroleum-based materials, that's good for everybody."

The research team is now investigating ways to replicate the fibres artificially, having already patented the process for making silk-like threads from the fibres. They hope to overcome obstacles to larger-scale production, such as assembly methods for spinning the protein fibres into threads.

Research collaborators from the University of Guelph include Prof. Todd Gillis and post-doctoral fellow Atsuko Negishi of the Department of Integrative Biology, Prof. Loong-Tak Lim of the Department of Food Science, and graduate students Timothy Winegard and Julia Herr. The team also includes Profs. Laurent Kreplak and Andrew Gilyan of the Department of Physics and Atmospheric Science at Dalhousie University.

Funding for this research is provided by AFMNet and the Natural Sciences and Engineering Research Council. ●

Prof. Doug Fudge (right), graduate student Timothy Winegard (centre) and post-doctoral fellow Atsuko Negishi say the slime from hagfish could produce an excellent, renewable fibre-based material.

Andra Zommers

Destroying shellfish toxins before they enter the food chain

By Carol Moore

Shellfish are a nutritious dietary staple, but they may have potentially harmful effects. In rare but serious cases, a potent neurotoxin produced by marine diatoms, called domoic acid (DA) or amnesic shellfish toxin (AST), has caused permanent memory loss and even death when ingested. But now, a group of AFMNet researchers from Dalhousie University are investigating bacteria that can destroy this marine biotoxin. Coincidentally, the bacteria can be found in the digestive tracts of shellfish themselves.

Prof. Tom Gill, Department of Process Engineering and Applied Science, and his research team have been working to isolate bacteria from shellfish that contain DA, such as blue mussels and soft-shelled clams. They're screening these bacteria for the ability to degrade DA, and then feeding competent encapsulated strains to shellfish infected with DA to see if they can degrade the harmful toxin.

In Gill's previous research on paralytic shellfish toxins (PSTs), another group of marine biotoxins, he found bacteria from blue mussels and soft-shelled clams that can break down these potent neurotoxins within one to three days. The idea to apply this work to DA came from research conducted in 1998 by Jim Stewart from Fisheries and Oceans Canada.

AST binds and accumulates in the tissues of shellfish. When ingested by humans, it binds to glutamate receptors – neural cells that normally bind glutamate and serve as prominent neurotransmitters. These transmitters induce neuron firing for cell and nerve function.

When AST binds to our glutamate receptors instead of glutamate, the neurons have an excitatory response, triggering an influx of calcium into the neural cell. These high doses of calcium can disturb cellular homeostasis, causing some neurons to die off and lose their firing function. If neurons are unable to fire, permanent memory loss and even death can occur.

Currently, there's no known antidote for AST. But ongoing test results suggest the Dalhousie team is on to something. Gill is using High Performance Liquid Chromatography (HPLC) to track the degradation of DA by bacteria in test tubes and in shellfish tissues. His goal is to create a practical, commercial means of encapsulating the powerful bacteria to be fed to AST-contaminated shellfish, making them safe for human consumption.

"We're looking for the magic silver bullet that will protect people from the toxin," says Carrie Donovan, a research associate and former master's student working with Gill. "We want to select competent strains of bacteria that will destroy the toxins within one to three days after being ingested by the infected shellfish."

Other investigators and collaborators involved in this project from Dalhousie are network investigator Rafael Garduno, Donovan and Elizabeth Garduno from the highly qualified personnel team, and Aquatron manager John Batt. They are working with Susan Shaw, a director at the Canadian Food Inspection Agency; Doug Bertram, CEO of Innovative Fisheries Products Inc.; and Bruce Hancock, general manager of Country Harbour Sea Farms.

Funding for the project is being provided by AFMNet. ●

And the survey says...

AFMNet Consumer Monitor helps identify consumer attitudes and trends

By Joey Sabljic

Dean Palmer

Profs. John Cranfield (left) and Spencer Henson are studying consumers' perceptions of certain food products to identify marketing trends.

Producers of new nutraceuticals and functional foods want to know how their products will be received by consumers. To that end, University of Guelph researchers are building a consumer food panel to track how these products are accepted and perceived in order to help producers make more informed business decisions.

Profs. John Cranfield and Spencer Henson of the Department of Food, Agriculture and Resource Economics have recruited 5,000 people in Ontario to be part of a consumer panel called the AFMNet Consumer Monitor. In total, 20,000 people are involved nationwide. The researchers are tracking consumer attitudes and perceptions towards food, diet and health. They also want to know how new food innovations are being perceived, as well as the ability of consumers to make dietary changes.

"We want to know what is influencing change in attitudes so that we can analyze these trends and pass on this knowledge to stakeholders," says Cranfield.

The AFMNet Consumer Monitor is based on a longitudinal panel, which allows Cranfield and Henson to measure how people respond to the same survey over a period of time. They can then link information about consumer attitudes towards food spending, confidence in local food providers and undertaking dietary change to socio-economic trends.

Cranfield adds that he and Henson are gaining insight into consumer preferences through stated preference questions and hypothetical questions. Stated preference questions allow respondents to state what they prefer when presented with a variety of options. Hypothetical questions ask respondents to make a decision when presented with a specific scenario.

For example, participants were asked whether they would deliberately purchase foods and beverages enhanced with omega-3, rather than omega-3 supplements. Twenty-five per cent more respondents said they would purchase omega-3 foods rather than omega-3 supplements.

In a survey on people's ability to undertake dietary change, the researchers found that men were much less likely than women to make changes to their diets. In particular, the study found that women over age 35 were much more informed than men of the same age about healthy diet. In addition, men over 35 were considerably less informed than women of the same age group about issues concerning personal health.

"With this information, we can see that one of the issues is placing an emphasis on getting men informed," says Cranfield. "Companies could then direct health food and nutraceutical marketing more towards men."

Henson and Cranfield plan to explore collaborative and commercial opportunities for the AFMNet Consumer Monitor, and what each identified trend in consumer attitudes towards new food innovations means for stakeholders. With this knowledge, stakeholders could make more informed business decisions and adjust their policies according to the most recent consumer trends.

This research is funded by AFMNet. ●

Help for the swollen colon

Researchers have isolated a peptide that can ease chronic gut disease

By Katelyn Peer

Egg Farmers of Ontario

Chronic gut inflammation – which is more common in Canada than the rest of the world – can develop into inflammatory bowel disease (IBD), colitis or Crohn's disease. Currently, one in 200 Canadians are suffering from IBD and 10,000 new cases arise every year. IBD may also put its sufferers at risk for cancer, diabetes, cardiovascular problems, high blood pressure and allergies.

But help is on the way. Researchers at the University of Guelph have become the first to detect amino acids and peptides in eggs that can greatly reduce colon inflammation. Now they're developing products that could deliver these amino acids and peptides to consumers.

Prof. Yoshinori Mine, in the Department of Food Science says this breakthrough has sparked collaboration with several other Canadian universities to develop a company called Sante Bioactives Ltd. under AFMNet that could spell relief for IBD sufferers.

"We are bringing all the brains to one company," says Mine. "We're going beyond the lab to bring people together."

Mine's team first tested the amino acids (cysteine and tryptophan) and peptides from eggs on an intestinal cell that was grown in a laboratory. Once inflammaton-reducing properties were discovered, the researchers began testing them on a pig model – pigs' gastrointestinal tracts are almost identical to humans. They found that pigs with a mild, temporary colon inflammation were back to their pre-inflammation state in five days after ingesting the cysteine, tryptophan or peptides.

Although these peptides could be a safe and holistic way of reducing colon inflammation, one shortcoming is that they're not available through normal diet and need to be isolated from the egg proteins.

That's where Sante Bioactives Ltd. comes in. Plans are already under way to market the peptides in the form of a capsule, beverage or power bar, which may be available to the public by 2012 if human trials (scheduled to take place next year) are successful.

This research is a highly interdisciplinary pursuit. Those involved at Guelph are Prof. Ming Fan, Department of Animal and Poultry Science, along with his PhD students Chengbo Yang, Dale Lackeyram and Tania Archbold. Also involved from Guelph are Mine's research associate Jennifer Kovacs-Nolan, PhD students Denise Young and Hua Zang, and postdoctoral fellow Suzanne Feng from the Department of Food Science.

Other collaborators include Max Hincke from the University of Ottawa, Edwin Wang of the National Research Council in Montreal, Prof . Rotimi Aluko from the University of Manitoba, Bertrand Chay Pak Ting and Yves Pouliot of the University of Laval, Robert Hancock from the University of British Columbia, Toshiro Matsui of Kyushu University in Japan, Francoise Nau from Institut National des Sciences Appliquées in France and Rong Cao, Agriculture and Agri-Food Canada.

This research is funded by AFMNet. ●

The battle intensifies against bacterial biofilms

By Natalie Osborne

Bacterial colonies that form on the surface of food processing equipment can pose serious health risks to consumers, such as the listeriosis disaster that claimed 21 lives in Canada last year. These complex bacterial clusters, known as biofilms, are difficult to detect and prevent and, once they're established, are almost impossible to remove.

A multidisciplinary team of researchers from across Canada, led by University of Guelph Prof. John Dutcher, Department of Physics, is rising to meet the challenge biofilms present to the food industry. The team is using nanotechnology-based equipment to investigate the survival of bacterial cells on surfaces, and to test possible methods for removal and prevention.

"We think about these problems in ways that differ from the traditional microbiology approach," says Dutcher. "A physicist, chemist and mathematician come at it from different points of view and our job is to bring all of these different ways of attacking the problem together."

Bacterial cells colonize almost any surface where nutrients and water are available, producing biofilms with a slime coating that protects individual cells within the colonies from antimicrobial agents, such as bleach. This makes conventional methods of sterilizing surfaces within food processing equipment ineffective against biofilms.

To understand the structure of biofilms on a molecular level, Dutcher's group uses a wide range of experimental and computational techniques, including an atomic-force microscope with a mechanism similar to that of a record player. A microscopic arm with a relatively sharp point at one end is moved over the surface of a sample and the tip shifts down or up in response to the attractive or repulsive forces between the tip and the surface. This allows the microscope to "map out" the physical characteristics of the biofilm.

Dutcher has also been experimenting with a nanoscale version of a technique called "creep relaxation," which is typically used by engineers to test the response of building materials to prolonged stress. Researchers in Dutcher's lab can measure the strength of the cell wall by pushing the tip of the arm into a bacterial cell for a few seconds at a

Researchers are developing a stronger defense against bacterial biofilms that can form on the surface of food processing equipment.

set loading force, and recording how far the tip sinks in. The nanoscale creep relaxation test reveals useful information on how to target the structural integrity and resilience of biofilms.

The researchers will also be developing and testing cationic antimicrobial peptides (CAPs), compounds that can penetrate the defensive molecular barriers surrounding bacterial cells in biofilms. CAPs are expected to be one of the more successful treatments for established colonies because of their ability to penetrate and compromise the bacterial cells within biofilms. Testing the effectiveness of CAPs on established colonies is one of the researchers' next steps.

Preventing biofilms from forming would be the ideal alternative to costly removal processes. To that end, part of this study will focus on ways to discourage colonies from growing on surfaces, such as stainless steel, by identifying and testing anti-biofilm compounds such as CAPs. As well, the researchers will be investigating the effects of changing the biofilm's environment – such as temperature, pH, relative humidity and nutrient levels – on the survival of the bacterial cells.

Maple Leaf Foods

"It's a molecular approach to understanding bacterial biofilms, and that's really what we're all about," says Dutcher. "Whether it's looking at them with sophisticated techniques to see what the molecules are doing, simulating it on the computer, or putting down a layer of some surface treatment that will try to prevent the formation of biofilms – it's all at the nanoscale level."

Other University of Guelph faculty members involved in this project are Profs. Hermann Eberl, Mathematics and Statistics; Chris Gray, Physics; and Cezar Khursigara, Molecular and Cellular Biology.

Other collaborators include Profs. Lori Burrows, Department of Pathology and Molecular Medicine at McMaster University; Bob Hancock, Department of Microbiology and Immunology at the University of British Columbia; David Pink, Department of Physics at St. Francis Xavier University; Bruno Tomberli, Department of Physics and Astronomy at Brandon University; Lisbeth Truelstrup Hansen, Department of Food Science and Technology at Dalhousie University; and Gideon Wolfaardt, Department of Chemistry and Biology at Ryerson University.

Funding for this research is provided by AFMNet. ●

More progress on the peptide front

Trials move from animals to humans for natural blood pressure treatment

By Joey Sabljic

Hypertension and kidney disease go hand in hand, yet drugs prescribed to treat hypertension often have adverse effects on kidney health. Soon, a natural food alternative that has been shown to significantly reduce hypertension and slow down kidney disease may land on pharmacy shelves.

Prof. Rotimi Aluko, Department of Human Nutrition at the University of Manitoba, has been developing and testing pea peptides – proteins that are hydrolyzed, or separated into smaller pieces. They lower hypertension by targeting renin activity, a key enzyme responsible for maintaining blood pressure.

"We are testing the peptides to see if they can help people with kidney disease by delaying the effects of the disease and helping them to lower their blood pressure," says Aluko.

His research has made the transition from test tube to living tissue with promising animal trial results for staving off kidney disease and hypertension. The trials showed that pea peptides led to a significant reduction in blood pressure.

Aluko also observed that the animals produced more urine, pointing to increased kidney function. Aluko has now started his first human trials, using volunteers with untreated, mild hypertension. Results are not yet available.

He's hoping to further this research by involving volunteers diagnosed with kidney disease. This portion will include identifying and purifying individual peptides responsible for the disease-fighting activity, as well as developing the peptide as a food additive or tablet. He expects these efforts to increase the project's commercial viability.

Funding for this project is provided by AFMNet, the Natural Sciences and Engineering Research Council and the Manitoba Centre of Excellence Fund. ●

Don't go with the flow

Healthier fats must not let oil pass through

By Carol Moore

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A collaborative research project is taking place across Canada to find a healthier and more functional replacement for the unhealthy trans fats used in food processing.

Profs. Alejandro Marangoni of the University of Guelph and Gianfranco Mazzanti of Dalhousie University — both food scientists — are working with Prof. David Pink, a physicist from St. Francis Xavier University, and Prof. Ben Newling, a physicist from the University of New Brunswick, to analyze the crystalline structure of fats derived from canola and soybeans. They want to see how oil flows through and binds to the crystalline network structure formed by stearic acid-rich fats.

They're also trying to determine what physical modifications they can make to these healthier fats to get the best product possible when they are used as laminating fats in flaky pastries, such as croissants and danishes.

"Fully hydrogenated, saturated fats are solid like wax," says Marangoni. "Our goal is to find a way to functionalize that into something that can withstand the folding and mixing of fats during the food-making process. However, we also have to prevent oil leaking from the fat mixture."

Marangoni will be analyzing how the materials are manufactured, using an industrial-size crystallizer at the Guelph Food Technology Centre. That will allow him to study how fat properties are affected by the crystals' size, the strength of intermolecular forces (forces that hold molecules together) and the amount of solid material.

The researchers hope to learn how to manipulate temperature and mixing to obtain optimal properties using these raw materials. They plan on coating the crystals with a surfactant, a wetting agent that lowers surface tension and changes both crystal size and crystal-crystal interactions.

"Mixing fat and oil would turn something from candle-like wax to something more like margarine or a shortening substance," says Marangoni. "But it still needs to be hard. This is the challenge."

Palm fat, imported from Malaysia, is popular in food processing due to its rock-bottom price, but Marangoni says it's not the healthiest or most environmentally friendly fat mainly due to the distances it must travel to market and the destruction of tropical rainforest. Finding a replacement fat that is more "green" is one of the project's major goals.

Stearic acid fits the bill on all counts. It's inexpensive, and, because it contains fats derived from canola and soybeans, it presents the opportunity to use locally grown crops that reduce the food industry's carbon footprint. Fully hydrogenated with no trans fatty acids, functionalized stearic acid fats are also a healthier alternative for consumers.

Funding for this project is provided by AFMNet, the Ontario Ministry of Agriculture, Food and Rural Affairs, the Natural Sciences and Engineering Research Council and the Canada Research Chairs program.

Getting the salt out

Controlled release may maintain taste with less sodium

By Johnny Roberts

Canadians consume twice the amount of salt they should, increasing the risk of severe health problems such as cardiovascular disease and stroke. Salt is hidden in processed and prepared foods – in fact, about 80 per cent of the salt Canadians consume is present in foods purchased at the grocery store and in restaurants. So even when you avoid the salt shaker, you can still get much more than you need.

Prof. Dérick Rousseau, Department of Chemistry and Biology at Ryerson University, wants to change that. He's leading a group of AFMNet-funded Canadian researchers developing strategies aimed at reducing salt in common processed foods.

Sodium chloride (common table salt) is a cheap and accessible commodity. Proper amounts of sodium help regulate vital bodily functions, such as fluid regulation throughout the body and blood pressure.

"Salt is an important and essential mineral for our health, but when consumed in excess amounts, it can have important health implications," says Rousseau. "With this research, we're trying to maintain that desired salty taste in processed foods, but by using 25 to 30 per cent less salt."

Salt is also valued by food processors. It increases the sensory appreciation of food through its impact on flavour and it can be an effective antimicrobial preservative. It's also important for the proper processing of many foods, such as bread and cheese.

However, high blood pressure has become a major health problem facing Canadians, in part due to excessive salt intake. Hypertension can increase the risk of numerous diseases, namely stroke and heart disease. There are currently more than five million Canadians who have some level of hypertension, in large part due to excess sodium intake.

Canada's healthcare system spends billions annually on the treatment of hypertension and its health consequences. Rousseau believes a multi-pronged, salt-reduction strategy – bringing together voluntary changes in the sodium content of processed foods with consumer education, federal legislation and novel technologies such as those his team is developing – will lower the average sodium intake, and offer significant cost savings to Canada's healthcare system.

Various ways of reducing or replacing salt have been attempted over the years. One relatively common approach is to use salt replacers, such as potassium chloride and magnesium chloride. However, these compounds fall short when it comes to flavour as they also confer a somewhat bitter aftertaste.

So instead of replacing sodium chloride in foods, Rousseau and his team will use an approach commonly used in the pharmaceutical industry, called controlled release. This tactic should still allow the taste buds to perceive ample saltiness, but with lower salt content.

"We need the support of the food industry for our research to be successful, and it's been very supportive so far," he says. "We're going to come up with tangible benefits for the processed foods industry."

This research is primarily funded by AFMNet, with support from the Canadian Stroke Network and two industrial partners. ●

Prof. Dérick Rousseau and molecular science graduate student Natasha Berry are developing ways to reduce salt in processed foods.

Ernesto DiStefano

Inside the human black box

New research could demystify gut bacteria to improve health and well-being

By Carol Moore

Chronic disorders such as inflammatory bowel disease and celiac disease are becoming more common, likely due to dietary changes and increased stress levels. Improving the well-being of patients affected by these chronic diseases, and reducing the economic pressures associated with escalating health problems, is the main goal for a research team from across Canada.

Researchers in Alberta, Nova Scotia and Ontario are assessing how microbial interactions and diet affect gut health and our general well-being. They're building on the results and information from past research to better understand the relationship between what we eat and how it ultimately affects gut health.

Prof. Brent Selinger, Department of Biological Sciences at the University of Lethbridge, is working with Doug Inglis and John Kastelic from Agriculture and Agri-Food Canada's (AAFC) Lethbridge Research Centre and Richard Uwiera, a PhD candidate in Veterinary Medicine from the University of Alberta. They're developing a new swine model to test how pathogens and probiotics interact with the host and microbial communities in the gut.

"The gut is like a black box," says Selinger. "We're working on developing new technologies and tools to decode it and better understand how it works."

The model being developed by the Alberta team will mimic the human gut. Surgical techniques being used to partition sections of the intestine will provide a realistic model for analyzing host-microbiota-pathogen-probiotic interactions. They will also reduce inter-animal variability, which is a significant problem associated with this type of research.

Moreover, the effects of various treatments on very specific regions of the intestinal tract can be examined in a highly prescribed manner. It is well documented that certain pathogens colonize particular regions of the intestinal tract and it is important to study the interaction with the host and intestinal microbiota at these locations.

The Alberta team is also using gene libraries, denaturing gradient gel electrophoresis, and terminal restriction fragment length polymorphisms (T-RFLP) to profile microbial communities within the intestinal tract. T-RFLP is a relatively new technology that increases the rate and number of samples that can be analyzed.

In addition, the team is using metagenomic analysis methods to better understand what is going on in the complicated and dynamic intestinal tract.

"Besides our goal of better understanding microbial communities within the intestine, a major emphasis of our research is to develop novel and efficacious treatments for acute and chronic intestinal problems, such as inflammatory bowel disease and Irritable Bowel Syndrome," says Selinger.

Martin Kalmokoff, a research scientist with AAFC, is investigating how dietary substrates alter and change the colonic community composition in monogastric animals, in order to assess how this impacts an individual's overall health and well-being.

At the AAFC research station in Kentville, Nova Scotia, Kalmokoff and his research group are analyzing gastro-intestinal communities to investigate how specific dietary fibres can alter the colonic bacteria community in rodents. Along with analyzing how the dietary fibres change the microbial communities, they're looking at the correlation between the changes in the community diversity and various immunological markers indicative of good health.

Lisa Waddington, a Dalhousie University graduate student working with Kalmokoff, has found that fructans (fructo-oligosaccharides and inulin) may change the composition of the human colonic bacteria community, but the changes aren't consistent from one individual to the next. Nonetheless, fructans are claimed to stimulate the selective growth of certain health-promoting intestinal bacteria and have a positive impact on host health.

The third component of this project is being completed at McMaster University by Profs. Elena Verdú, Stephen Collins and Premysl Bercik, Department of Medicine. They're looking at how changes in the gut microbiota can affect central nervous system function and how probiotics can reverse the harmful effects of inflammation in the gut, which may cause chronic intestinal diseases such as Irritable Bowel Syndrome.

"If gut health is not improved, there could be chronic physical and economic impacts on society," says Verdú. "We want to improve the long-term well-being of these individuals and ease some of the economic pressures."

Also involved in this project are Drs. Steven Brooks and Kylie Scoggan, Bureau of Nutrition Research at Health Canada; Hermann Eberl, University of Guelph Department of Mathematics; and Tom Boileau from General Mills Inc. in Minnesota.

Funding for this project is being provided by AFMNet, Agriculture and Agri-Food Canada, Health Canada, General Mills Inc., the Alberta Life Science Institute, the University of Alberta and the University of Lethbridge. ●


Rod Leland

Prof. Brent Selinger is looking closely at the relationship between what we eat and how it affects our gut health.

Towards safer supplements

By Natalie Osborne

Meeting the daily requirement of folate, a form of B vitamin, is important for maintaining good health. But the synthetic form of folate, called folic acid, can hide neurological lesions caused by B-12 deficiency. AFMNet researchers are aiming to develop a safer, alternative form of folate supplement that will meet dietary requirements without masking symptoms of deficiency.

Currently, Canadian law mandates that grain products be supplemented with folic acid to meet people's basic dietary needs for the vitamin. Drs. David Kitts, Tim Green, Zhoaming Xu, Angela Devlin and Jerzy Zawistowski from the Food, Nutrition and Health program at the University of British Columbia have joined forces with Dr. Laurent Bazinet from the University of Laval to find a way to supply alternative folates using micro-encapsulation technology.

This technology is a small-scale version of the layering technologies used in electronics and optics, in which the micro-encapsulation process surrounds a compound with a protective polymer coating.

"We are working with reduced forms of folate, which are naturally present in some of our foods and are the form of the vitamin used by our body. Unfortunately, they're relatively less chemically stable than the synthetic folic acid and can be lost during food processing and preparation," says Kitts. "Encapsulating them in microscopic protective materials could be the solution."

Folates are involved in many important functions throughout the body, including production of genetic materials (DNA) and cell growth. A folate deficiency can lead to problems with a developing fetus, most notably neural tube defects, such as spina bifida. For this reason, folic acid supplements for pregnant women are particularly vital.

The researchers hope to develop the reduced folate into a stable, viable ingredient to fortify staple food products, such as bread or pasta. Coating the reduced folate in protective layers on the micro-scale could help them survive the harsh conditions of a food processing plant.

After determining if the reduced folate can resist processes like fermentation and baking, researchers will also ensure the encapsulated folate is bioavailable. (Bioavailability is the measure of how effectively the compound can circulate in the body and reach its desired targets.) These researchers will be the first to examine this property of reduced folate.

Additional studies will initially experiment with micro-encapsulation of folate for mice, and may apply this technology later in human clinical trials. These trials require a slightly folate-deficient population, and will most likely take place in Southeast Asia, where folate supplementation is not yet mandatory. The researchers are contacting universities in Malaysia and Vietnam for a possible partnership.

Kitts' teams will also use nutrigenomics to gain a better understanding of how folates interact with genes, especially during early development. Devlin's laboratory will examine how folate nutrigenomics can influence gene expression, and by extension, the production of proteins vital to cell structure and function.

"The more we understand about folate, the closer we are to developing a safe, effective supplement," says Kitts. "With reduced folate, we could get the best of both worlds – stability and bioavailability – without possible negative side effects."

Funding for this research is provided by AFMNet. ●

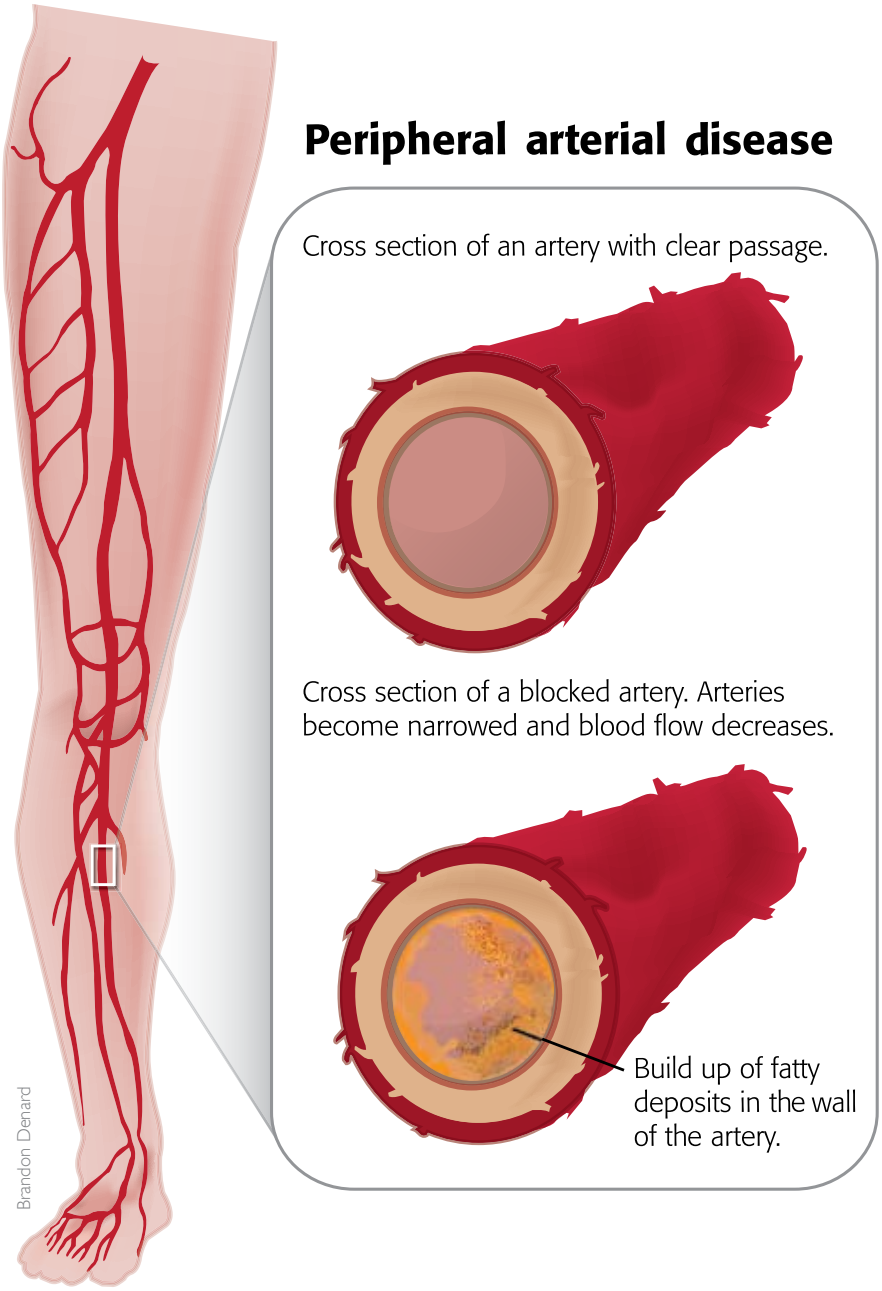
Dr. David Kitts, pictured here with PhD student Ingrid Elisia, is using micro-encapsulation technology to develop a new, safer folate supplement.

Martin Dee

Saving life and limbs

Daily flaxseed consumption can prevent death by peripheral arterial disease

By Anupriya Dewan and Vanessa Perkins



Peripheral arterial disease (PAD), caused by blood clots in the arteries, is sometimes called a silent killer. It can reduce or completely block blood flow to peripheral limbs, which can lead to the need for amputation, or be deadly. Research has found that regular flaxseed consumption may reduce the risk.

Dr. Randy Guzman, a vascular surgeon and researcher at St. Boniface General Hospital in Winnipeg, and his research team are conducting clinical trials to determine if moderate, daily consumption of ground flaxseed can prevent or treat PAD.

Research has revealed that flax consumption may reduce atherosclerosis and irregular heart rhythms. The clinical study involving patients aims to determine if consuming as little as 30 grams of ground flaxseed per day can reduce PAD's progression, or other cardiovascular events, such as a stroke or heart attack.

"We're trying to find dietary changes everyone can make that directly increase survival rates," says Guzman.

The risk of PAD increases as one ages, yet many patients don't show any symptoms until the disease progresses further into limb or heart-related problems. Guzman also has concerns about Canada's aging population, as PAD could put a strain on the healthcare system.

The research trials done on older patients have shown that the omega-3 fatty acids contained in flaxseed reduce cholesterol and the likelihood of blood platelets clotting together. By adding a moderate amount of flaxseed to their diet, Guzman says the older population could be spared some of the consequences of this devastating disease.

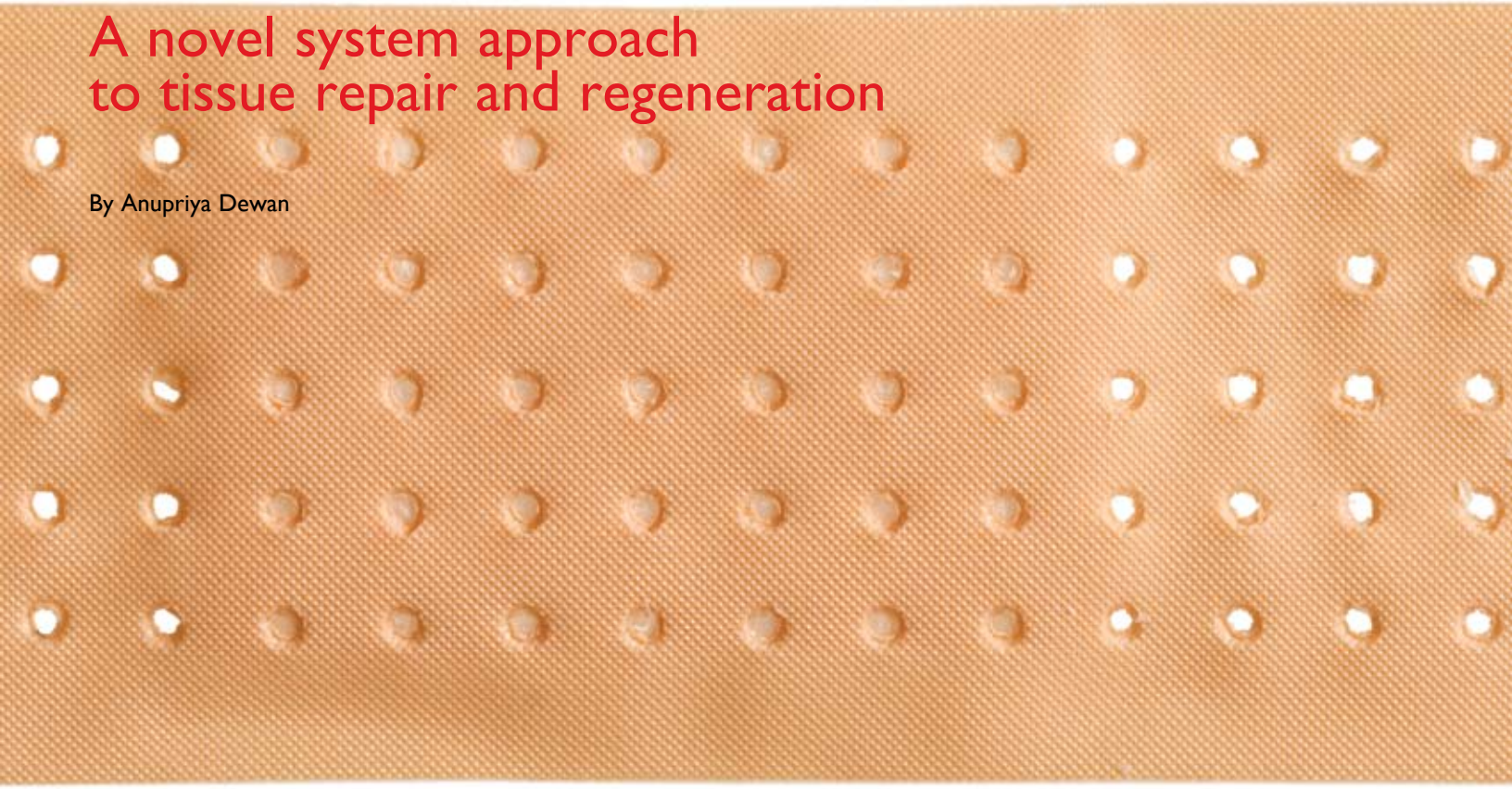
Also working on this project are Chantal Dupasquier, a PhD candidate in the University of Manitoba's Department of Physiology and Drs. Grant Pierce, Bram Ramjiawan, Delfin Rodriguez-Leyva and Peter Zahradka from the Canadian Centre for Agri-Food Research in Health and Medicine.

Funding for this project is provided by AFMNet, the Canadian Institutes of Health Research, the Heart and Stroke Foundation of Canada, Agriculture and Agri-Food Canada and the Province of Manitoba. ●

The right tools for

A novel system approach to tissue repair and regeneration

By Anupriya Dewan



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Tissue regeneration is a complex process. It requires the availability of certain types of cells, biochemical signaling compounds and appropriate scaffold materials for the process to take place efficiently. Researchers are developing a new delivery system consisting of a degradable gel incorporating biodegradable nanofibers for neural stem cell delivery, which could speed up the healing process after a spinal cord injury.

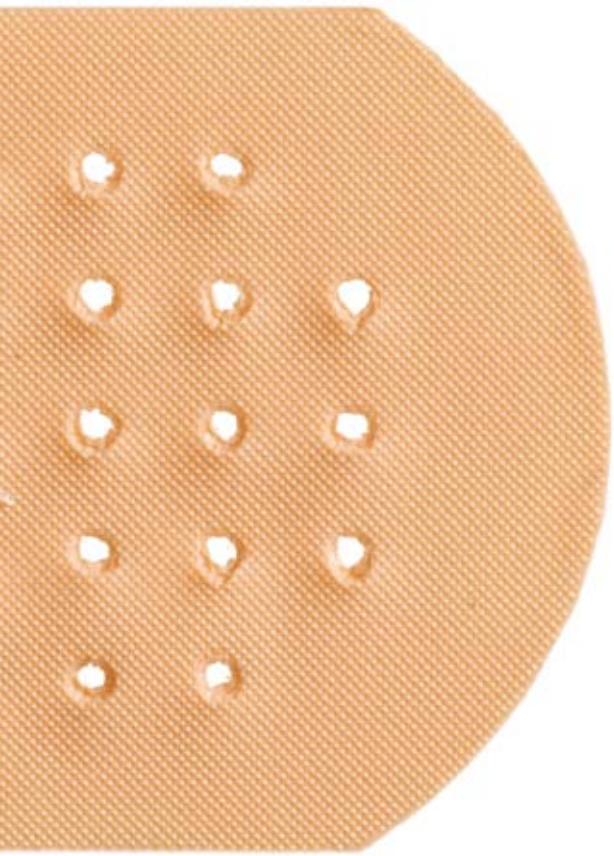
Prof. Wankei Wan, Department of Chemical and Biomedical Engineering at the University of Western Ontario, is collaborating with several researchers, including Profs. Molly Schoichet, Department of Chemical Engineering and Applied Chemistry at the University of Toronto; Brian Amsden, Department of Chemical Engineering at Queen's University; and Phillip Choi, Department of Chemical and Materials Engineering at the University of Alberta. They're all actively involved in the use of this and other related approaches to investigate tissue engineering and regeneration processes relevant to the repair of body tissue and organs.

"It's a very natural collaboration because we're providing complementary skills and expertise that are essential to the success of this project," says Wan.

Through efforts by Wan and Amsden, nanofibers that are degradable and biocompatible have been produced from poly(ε-caprolactone-co-D,L-lactide) (PCL-DLLA) and collagen using a process called electrospinning. Wan is trying to incorporate biochemical signaling compounds into the nanofibers. These compounds, which can be released at a controlled rate, would help stimulate cell differentiation and proliferation leading to effective healing and tissue regeneration. The bioactive fibers can be delivered to an injured site by incorporation into biodegradable injectable gels based on hyaluronan/methyl cellulose and glycol chitosan that are currently one of the foci of research by Schoichet and Amsden.

"Even though we're focusing on biomedical applications, the nano-delivery system we're developing may have a broad range of applications. The system could be used for the

the job



delivery of nutraceuticals, such as polyunsaturated fatty acids, and also in pharmaceuticals to prolong their effectiveness," says Wan.

The research team is now preparing core-shell structured nanofibers by incorporating bioactive compounds and studying the release process. Team member Choi, an expert in modeling and simulation, will provide an understanding of the release process.

Collectively, the team hopes to create customized systems using a combination of gel, fiber and cell that are effective in specific tissue regeneration processes and can be applied to spinal cord injuries, ligament and tendon repairs, heart valve tissue engineering and other healing and repair processes.

Funding for this project is provided by AFMNet. ●

Friendly bacteria versus pesky fungi

By Katelyn Peer

Post-harvest decay in pome fruits, such as apples and pears, spreads quickly in cold storage even if only one piece of fruit is contaminated. This can reduce growers' and packinghouses' profits by 10 to 20 per cent. To rein in the problem, a researcher at the University of British Columbia's Okanagan campus has developed two environmentally friendly methods to detect and control decay.

"There's been a worldwide move towards developing environmentally friendly ways of controlling disease in fruits," says Prof. Louise Nelson, Department of Biology and Physical Geography. "If we're able to use these methods, we'd be the first in Canada."

Currently it takes weeks to identify fungal contaminants on fruit. Samples are sent to a provincial laboratory where the fungus is grown and tested before the results are sent back.

But Nelson has developed a new approach using DNA, which may take only 24 hours.

Short sequences of DNA are attached to a nylon membrane or array, which can identify and quantify fruit-specific pathogens. If there's a match, a dark spot appears on the membrane, and the spot's density reveals the amount of pathogen detected.

Nelson is also examining five different strains of soil bacteria that can be used to suppress the growth of common fungal pathogens. These benign, environmentally friendly bacteria are applied to the fruit and have proven to be at least as effective as chemical fungicides currently on the market.

This research is taking place at labs and research plots at UBC Okanagan as well as commercial orchards in Kelowna.

Nelson confers with Peter Sholberg, a research scientist at the Pacific Agri-Food Research Centre; Danielle Hirkala, a research scientist at the Okanagan Tree Fruit Cooperative who did her post-doctoral studies at UBC on this topic; Daylin Mantyka, a master's student in the Department of Biology and Physical Geography at UBC Okanagan; and undergraduate and co-op students.

The research is funded by AFMNet. ●

Don't blame your genes

Genetic variation can help delay vitamin C deficiency, but nothing beats a balanced diet

By Anupriya Dewan

Genes can play an important role in maintaining adequate blood levels of vitamin C if your dietary intake is insufficient. But meeting your recommended dietary allowance is your best bet for good health, say researchers from the University of Toronto.

Prof. Ahmed El-Sohemy and registered dietitian and PhD candidate Leah Cahill of the Department of Nutritional Sciences at the University of Toronto are determining the role genes play in vitamin C deficiency.

"Although scurvy is now very rare in Canada," says Cahill, "low vitamin C levels are indicators of health conditions that may affect people later on in life."

Scurvy – a disease caused by low vitamin C levels – is known historically for commonly occurring in sailors who spent months at sea without eating fruits or vegetables. The role genes play in this deficiency was apparent even at that time. With everyone having a uniform diet, why didn't everyone develop scurvy at the same time?

The answer may lie in glutathione S-transferase (GST), an enzyme which recycles vitamin C. Vitamin C's role as an antioxidant requires it to continuously bind to dangerous molecules, such as free radicals, preventing those unpredictable compounds from doing any damage.

If GST is unable to salvage a vitamin C molecule, the molecule is eliminated and the individual needs to consume more vitamin C to maintain required levels. GST's recycling capacity and efficiency depends on genes with three common variations – GSTM1, GSTT1 and GSTP1.

Previous research has found that people with inactive forms of GSTT1 and GSTM1 can't regenerate vitamin C as effectively as others, which causes them to become deficient very quickly if they're not consuming enough in their diet. El-Sohemy and Cahill say that at least one in three participants in their study had one of these genotypes.

The team looked at students between the ages of 20 and 29. Some of them were nutritional sciences students at the University of Toronto. They found that one in seven participants had levels close to what could be classified as scurvy and that a further one in three had sub-optimal levels of this essential vitamin.

"Not all of our study participants are consuming enough fruits and vegetables," says Cahill. "The numbers are concerning."

It's vital to have adequate vitamin C. Among other roles it plays in the body, its level in the blood can act as an indicator of other potential health complications, such as metabolic syndrome. Metabolic syndrome is characterized by elevated body mass index and increased waist circumference and can lead to diabetes and cardiovascular disease later in life.

The researchers say that taking supplements or eating more fruits and vegetables to increase blood levels of vitamin C won't necessarily reduce your chances of developing metabolic syndrome, but it's a step in the right direction.

In the future, the team will be looking at other genes that may be playing a role in vitamin C absorption and recycling.

Prof. Paul Corey from the Dalla Lana School of Public Health at the University of Toronto was also involved in this study.

Funding for this project is provided by AFMNet. ●

Vitamin C deficiency is a target for PhD student Leah Cahill (left) and Prof. Ahmed El Sohemy.

James Brylowski