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A WORD FROM THE DIRECTORS

If the past is any indication, it is clear from the work that has been accomplished in recent years that the future is promising for INAF and its members. The past four years have been particularly replete with success with the undertaking of multiple keystone projects. Numerous partnerships with prestigious institutions have also contributed to raising the international profile of our researchers’ expertise.

This report presents an overview of the many activities and projects that INAF members brought to fruition between 2012 and 2016. It demonstrates how our group has excelled at upholding the four pillars of its mission: research, training, knowledge transfer and innovation support.

Multidisciplinarity is an integral part of INAF’s DNA. Since 2012, the Institute has enriched itself with new expertise by integrating approximately twenty new researchers from different universities in the province of Quebec. As the only strategic group in Quebec working in the high priority fields of agri-food, nutrition and health, the work done at INAF is supported by more than $20 million in research funding each year and contributes to the training of more than 400 graduate students.

The strong growth in infrastructure investments has also boosted the group’s attractiveness as well as its competitiveness both on the local and international scales. This development puts our network of researchers and our partners at a significant advantage and serves to bolster the offering of healthy, nutritious and delicious foods. It will also contribute to increasing the sector’s competitiveness and the health of our populations. Furthermore, the new Food Quality Observatory will contribute to improving both the nutritional quality and accessibility of Quebec’s food offer by working together with all actors in the sector, specifically the ministries involved.

Lastly, the continued success of INAF’s flagship event – BÉNÉFIQ, the international rendezvous on health ingredients – as well as the organization of numerous knowledge transfer activities, contributes to solidifying scientific and business partnerships while attracting both elite scientists and world leaders in the food and ingredients sector.

Sylvie Turgeon
INAF Director

Renée Michaud
Executive Director and Director of Development

INAF has generated more than $20 million in research funding per year and has contributed to the training of more than 400 graduate students.
NEW HORIZONS, SAME MISSION

The innovative approaches taken at INAF generate new knowledge in the natural sciences and engineering, health sciences and the social sciences to address every aspect of food and health. Always with the goal of broadening our knowledge of food and its components, INAF works to foster the development of new ingredients and foods, to validate their safety and their effects on health, and to propose nutritional approaches that promote the adoption of healthy eating habits at every stage of life.

In only fifteen years, INAF has established itself as a leader in the field and has proven that “Science enhancing nutrition” isn’t just a slogan. Its success stems from its commitment to the four pillars of its mission:

• To contribute to the TRAINING of highly qualified personnel;
• To ensure the TRANSFER of knowledge and technology; and
• To support INNOVATION in the industry and in health approaches.

RESEARCH | TRAINING | KNOWLEDGE TRANSFER | INNOVATION

The INAF network is composed of members from eight universities, a college centre for the transfer of technologies (CCTT) and Agriculture and Agri-Food Canada. It receives financial support from the Fonds de recherche du Québec as part of its Strategic Clusters program – Nature and Technologies. INAF’s productivity is the result of exceptional dedication on the part of all member researchers, professionals and students. We would like to highlight the multiplier effect of a collaborative culture as a core component of the group.
**HIGHLIGHTS**

**2013**

Awarding of two CIHR grants for research on food and health:

**Compliance with nutritional recommendations: Identification of measures, determinants and interventions ($1.8M - 5 years).**
INAF researchers: Simone Lemieux, Catherine Bégin, Charles Couillard, Sophie Desroches, Benoît Lamarche, Véronique Provencher, Julie Robitaille and Marie-Claude Vohl.

**Fish nutrients and prevention of metabolic syndrome ($2M - 5 years).**

Creation of the **Louise and André Charron Research Chair on Alzheimer's Disease (AD)**
Study of the role of oxidative stress in the development of AD and identification of biomarkers that precede the appearance of symptoms ($1M - 5 years).
Charles Ramassamy (Chairholder).

Creation of the **Aliment’Terre summer camp** focusing on food and nutrition, for youth ages 10 to 12. Owing to its mission and popularity, the camp received the 2015 DUX Prize (Institutional Projects category).

**2012**

First edition of **BÉNÉFIQ, the international rendez-vous on health ingredients.** INAF is the driving force behind this event that brings together scientists and business people – the only one of its kind in Canada. The second edition, in 2014, drew more than 600 participants, making BÉNÉFIQ an industry event that is not to be missed.

**Fish nutrients and prevention of metabolic syndrome ($2M - 5 years).**

**New Research Chair on Brain Metabolism and Cognition during Aging** at the initiative of the Faculty of Medicine and Health Sciences with support from the Fondation de l’Université de Sherbrooke. Study of brain fuel metabolism of omega-3 fatty acids during the normal aging process. ($1.68M - 6 years). Stephen Cunnane (Chairholder).

Signing of the France-Québec International Associated Laboratory (IAL) **OptiNutriBrain**, on nutrition and brain health. Frédéric Calon (Université Laval) and Sophie Layé (Université de Bordeaux).

**Launching of the Neurophenols Consortium**, a France-Quebec, university-industry project dedicated to research and development of natural ingredients for the prevention of age-related cognitive decline ($1.3M Quebec portion). Frédéric Calon, Yves Desjardins, Charles Ramassamy, Catherine Bégin and Carol Hudon.
Creation of a second France-Québec International Associated Laboratory in Bioproduction of Natural Antimicrobials (LIAAN). Ismaïl Fliss and Laurent Bazinet (Université Laval), Pascal Dhulster and Djamel Drider (Université de Lille).

Obtaining of $3.2M in funding from the Ministère de l’Économie, de l’Innovation et des Exportations (MEIE) for multidisciplinary facilities for the study of food safety, quality and eco-design dedicated to graduate students in the Department of Food Sciences.

Obtaining of the NSERC-Novalait Industrial Research Chair on Process Efficiency in Dairy Technology. The objective of the chair is to develop expertise in process efficiency to optimize the economic, environmental and social benefits of the Canadian dairy sector ($1.8M - 5 years). Yves Pouliot (Chairholder).

Infrastructure Development - Phase III

Obtaining of a $6.2M grant from the Canada Foundation for Innovation (CFI) for the construction of a kitchen-workshop, a dining area and facilities dedicated to leading-edge research in the culinary sciences and consumer behaviour.

Between 2012 and 2016, 300 students obtained their master’s or PhD diplomas after completing studies at INAF. More than 90% of the students trained by INAF member researchers found employment in fields related to their research.

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INAF Activities Report 2012-2016

**AN ACTIVE AND PRODUCTIVE GROUP**

INAF AT A GLANCE

- **80** regular researchers and research associates
- **50** professionals, assistants and specialized technicians
- **400** master’s students, PhD students and postdoctoral fellows annually
- **9** universities, College Centres for the Transfer of Technologies (CCTT), Agriculture and Agri-Food Canada
- **$20M+** annual research budget

2012 TO 2016

- **16** research chairs
- **134** merit scholars
- **300** MSc and PhD graduates
- **690+** research projects
- **1,700+** publications
- **1,500+** scientific communications
- **$11.6M** in investments in infrastructure and equipment

MORE THAN $20 MILLION ANNUALLY FOR THE ADVANCEMENT OF SCIENCE

The 2012–2016 period was particularly productive for INAF researchers, with funding averaging $20 million per year. Team-based research projects have made up nearly 40% of the average annual budget over the past five years, demonstrating the multidisciplinary and intersectoral nature of the research led at INAF. Grants for individual researchers, which mainly finance fundamental research projects in their fields of expertise, constituted 26% of the budget. Research chairs (industrial, Canada Research Chairs or capitalized) made up 9% of the budget. A total of 9% of the budget is attributed to contracts fulfilled by Innovation Support Services (ISS) and by individual researchers. Lastly, INAF’s operating budget (salaries, infrastructure maintenance, outreach) amounted to 7% of the budget.

Distribution of the average annual budget (%)

- **39%** Team grants
- **26%** Individual grants
- **10%** Infrastructure and equipment
- **9%** Chairs
- **9%** Contracts
- **7%** Operations

- **2012 TO 2016 annual research budget**
  - **$20M+**
The years 2014–2015 and 2015–2016 were particularly rich in grants for infrastructure and equipment. Significant funding was granted for the completion of two major projects which would not have been possible without the unwavering support provided by the Faculty of Agriculture and Food Sciences (FSAA).

The first project concerned the renovation of the Food Physico-Chemistry Laboratory in the Paul-Comtois Pavilion, critical to the investigation of the role of different food components in the nutritional value and functionality of foods. New equipment will be used to develop innovative and eco-friendly biomolecule fractionation methods. The project, supervised by Laurent Bazinet and multiple researchers from INAF and the Department of Food Sciences, contributes to the quality of the research environment provided to graduate students in food sciences and technology.

The second large-scale project (CFI Phase III), supervised by Sylvie Turgeon and a multi-faculty team from Université Laval, will also include the renovation of research spaces, to be located in the Université Laval Services Pavilion. The project includes the implementation of a culinary sciences research platform and a behavioural studies complex to study the determinants of adopting healthy eating habits. The facilities, which will be completed in 2018, will include a kitchen-workshop, a gastronomy and culinary sciences co-creation laboratory and spaces dedicated to research teams from the Food Quality Observatory and the Clinique Nutrition Santé.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Research projects</td>
<td>$13.4M</td>
<td>$16.0M</td>
<td>$18.1M</td>
<td>$16.8M</td>
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<tr>
<td>Infrastructure and equipment</td>
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<td>$0.9M</td>
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<td>Chairs</td>
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<td>$2.0M</td>
<td>$1.9M</td>
<td>$2.2M</td>
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<tr>
<td>Total</td>
<td>$16.4M</td>
<td>$18.9M</td>
<td>$24.8M</td>
<td>$23.5M</td>
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<tr>
<td>Contracts</td>
<td>$2.3M</td>
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<td>$2.6M</td>
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<tr>
<td>Operations</td>
<td>$1.3M</td>
<td>$1.4M</td>
<td>$1.9M</td>
<td>$2.0M</td>
</tr>
</tbody>
</table>

* Excludes funding from CERC and CFI Phase III

The years 2014-2015 and 2015-2016 were particularly rich in grants for infrastructure and equipment.
DIVERSE FUNDING SOURCES

Research funding comes primarily from large federal funding agencies (NSERC, CIHR, CFI), provincial agencies (FRQNT, FRQS, MAPAQ) and private funds. These include numerous industrial partners from the agri-food and life sciences sectors, sectoral associations (including clusters and agricultural associations) and research foundations (such as heart disease, diabetes and Alzheimer’s foundations). The City of Quebec, Québec International and the Health Food Consortium also play a catalytic role in the establishment of keystone projects at INAF. On average, in the past four years, more than 40% of the funding received has been the fruit of contributions from public-private partnerships and contracts. This large proportion of funding from private and partnership sources is a clear indication of the synergy between scientists and users of INAF’s research results. It also underscores the importance of the research and major forward-thinking projects that are currently underway.

Agri-food companies, sectoral associations and foundations primarily support thematic research projects and the creation of industrial research chairs with the goal of advancing science in their respective sectors. Research partnerships bolster innovation in the industry, specifically to offer consumers foods of a nutritionally superior quality whose health claims have been scientifically proven. Organizations such as CRIBIQ, Mitacs, Novalait, Genome Quebec, Genome Canada and the ACCORD clusters are the primary organizations that fund research partnerships.

On average, more than 40% of the funding received has been the fruit of contributions from public-private partnerships and contracts.

In regard to the operating budget, funding mainly comes from FRQNT Strategic Cluster grants awarded to the Institute since 2008, as well as major contributions from Université Laval and the Faculty of Agriculture and Food Sciences (FSAA). Support from FSAA is furthermore critical to INAF’s success. Added to this are structural grants from MAPAQ and other sources of self-funding related to external services and events organized by INAF.
While all foods can be studied at INAF, a large proportion of the budget is dedicated to projects related to the major economic sectors in Quebec. A large amount of work (nearly 40% of the budget) focuses on milk components and dairy products, plant products and extracts (particularly berries), as well as marine products and co-products and, most recently, meat products. Certain projects also examine the use of microorganisms of interest in the agri-food sector.

The goal of the research led at INAF is to develop knowledge about the close links between food and health. No less than 35% of the research budget over the past four years has been dedicated to projects related to the prevention of diabetes, metabolic syndrome, heart disease and obesity. Much of this work is the fruit of close collaborations with the Quebec Heart and Lung Institute (IUCPQ), affiliated with Université Laval. The effect of food on brain health also remains a topic of interest, while the issue of eating behaviour is ever-growing, specifically with the arrival of new psychology experts. Research teams examine, for example, eating habits, consumer purchasing reflexes as well as the impacts of marketing and labelling on food choices.

Identifying, characterizing and shedding light on the role of different bioactive molecules to improve health remains central to the research conducted at INAF. Numerous molecules of interest have been subject to extensive study, including peptides and proteins, polyphenols, fibres, lipids, vitamins and micronutrients from diverse sources. Researchers also conduct work using numerous technologies for biomolecule fractionation, preserving nutritional and organoleptic quality, and prolonging food longevity with the goal of boosting the sector’s competitiveness. This work, which falls under Research Themes 1 and 2, represents one-fourth of research investments.

Between 2012 and 2016, INAF researchers published more than 1,700 articles in peer-reviewed scientific journals. One-third of these publications involved the collaboration of at least two researchers from different fields of expertise, demonstrating the transdisciplinarity of the research led at INAF.

In addition, more than 1,500 conference proceedings confirm the active participation of researchers on national and international conference platforms. All of these publications — as well as 300 reports, scientific opinions, book chapters and contributions to collective works — have contributed to the exerted influence and increasing recognition of the expertise and multidisciplinarity of INAF researchers and collaborators on the international scale.
FROM THE TEST TUBE TO THE TABLE

Breakthrough innovations

INAF researchers are also active in innovation. Numerous breakthroughs have justified applying for patent protection. Such is the case for a new product developed by the research team led by Charles Ramassamy who has obtained an international patents for an anthocyanin formulation that can be used to treat neurological diseases. The discovery by the team led by André Marette of a molecule called Protectine DX, used to regulate blood sugar levels, has also been the subject of patent applications in Europe, Canada and the United States. This natural isomer, derived from omega-3 fatty acids, can be used to treat metabolic syndrome, insulin resistance and type 2 diabetes, as well as in muscle recovery. Other patents are pending for specific processes: one for the extraction of polyphenols from berries and another for obtaining a high-purity lignin that will give rise to high value-added applications (Tatjana Stevanovic).

Two large-scale research projects, led in partnership with the companies NutraCanada (acquired by Diana Food, France), Activ’Inside (France) and Atrium Innovations (Canada, United States), have resulted in the issuing of a licence for the marketing of innovative natural health products:

- Alpha Lipoic Acid + GlucoPhenol for managing blood glucose level and cardiometabolic health;
- Optimized Curcumin + Neurophenol for improved cognitive functioning;

The Ontario-based company Ovensa, specialized in biotechnologies, has also obtained a licence for the production and marketing of a chitosan derivative with antibacterial properties, produced from Nordic shrimp shells. The product was developed by the team led by Jonathan Gagnon, from Université du Québec à Rimouski (UQAR), for use in the pharmaceutical, cosmetic and nutrition sectors.

In addition, licences were also granted for:

- a process for the production and lyophilization of lactic acid bacteria for the creation of a fermenting agent (Tony Savard);
- the fixation of molecules to the surface of nanomaterials used in the fields of medicine and biology, as well as the environmental field (Nicolas Bertrand); and
- a food frequency web tool using a database on eating habits (Benoît Lamarche).

Adaptation innovations

Our researchers and ISS provide support – year in, year out – to numerous industries to improve their current product offering through new packaging, new formulations or by adding health benefits, for example. The most common catalyst for innovation, however, remains our graduate students who integrate into companies and participate in the innovation process.

INAF researchers are also active in innovation. Numerous breakthroughs have justified applying for patent protection.
### OUR MANY AND VARIED CHAIRS

The excellence and relevance of the work carried out at INAF is evident in the number of research chairs active between 2012 and 2016. Of these 16 chairs, four were Canada Research Chairs, five were Industrial Research Chairs and six were philanthropic chairs, as well as the very recent Research Excellence Chair which will begin on June 1, 2017.

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<th>Canada Research Chairs</th>
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<td>Canada Research Excellence Chair in the Microbiome-Endocannabinoidome Axis in Metabolic Health</td>
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<td>Canada Research Chair in Physical Activity, Nutrition and Energy Balance</td>
<td>Angelo Tremblay</td>
<td>2022</td>
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<tr>
<td>Canada Research Chair in Animal Reproductive Applied Functional Genomics</td>
<td>Marc-André Sirard</td>
<td>2021</td>
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<tr>
<td>Canada Research Chair in Lactic Cultures Biotechnology for Dairy and Probiotic Industries</td>
<td>Denis Roy</td>
<td>2017</td>
<td>$1,400,000</td>
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<tr>
<td>Canada Research Chair in Genomics Applied to Nutrition and Health</td>
<td>Marie-Claude Vohl</td>
<td>2017</td>
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<table>
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<tr>
<th>Partnership Research Chairs</th>
<th>Chairholder</th>
<th>End date</th>
<th>Total amount</th>
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<tr>
<td>Egg Industry Economic Research Chair (French description)</td>
<td>Maurice Doyon</td>
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<td>Chair on the Metabolism of Lipids during Aging (French description)</td>
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<td>2021</td>
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<td>Research Chair in the Pathogenesis of Insulin Resistance and Cardiovascular Diseases</td>
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<td>Louise and André Charron Research Chair on Alzheimer’s Disease</td>
<td>Charles Ramassamy</td>
<td>2018</td>
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<td>Research Chair on Brain Metabolism and Cognition during Aging (French description)</td>
<td>Stephen Cunnane</td>
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<td>NSERC-Novalait Chair on Process Efficiency in Dairy Technology (French description)</td>
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<td>J.A. DeSeve Academic Chair in Nutrition (French description)</td>
<td>Emile Levy</td>
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<td>NSERC-Novalait-DFC-FPLQ-MAPAQ-Valacta Industrial Research Chair on Nutritional Control of the Production of Milk Components in Dairy Cows (French description)</td>
<td>Yvan Chouinard</td>
<td>2015</td>
<td>$2,022,058</td>
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<td>Pfizer-CIHR Research Chair on the Pathogenesis of Insulin Resistance and Cardiovascular Disease</td>
<td>André Marette</td>
<td>2012</td>
<td>$1,442,446</td>
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* Click on the chair titles for more details.
RESEARCHING THE CONNECTION BETWEEN FOOD AND HEALTH

INAF researchers, their teams of professionals and graduate students lead fundamental, applied and clinical research impacting more than 40 scientific food-related disciplines.

Their research focuses on three highly complementary main themes, with researchers working in synergy to advance knowledge about human food and its impacts on health:

**THEME 1**
Identification, characterization and functionality of biomolecules
focuses on food components: lactic and probiotic bacteria, fatty acids, polyphenols, polysaccharides, proteins, peptides and many others

**THEME 2**
Technologies and processes for matrices and functional foods
consists of developing nutritious ingredients and foods using innovative, cost-effective and eco-friendly technologies

**THEME 3**
Nutrition and health
combines different fields of expertise in the development and validation of preclinical and clinical models, as well as in nutrigenomics and human behavioural studies

**RESEARCH OBJECTIVES**

**THEME 1**
Valorize bioactive molecules from natural sources (microbial, plant, animal, terrestrial, marine).
Characterize the molecular makeup and functions of these bioactive molecules and microorganisms.
Understand the structure-function relationship and the active mechanisms behind their physiological activity.

**THEME 2**
Develop new, environmentally responsible fractionation and food processing technologies.
Study the impact of the food matrix on the stability, bioactivity and health impacts of biomolecules.
Develop new matrices to protect, transport and release biomolecules at the site of action.
Validate the impact of new processes on food quality and safety.
Formulate new lines of ingredients, beverages and functional foods.

**THEME 3**
Describe the benefits of functional biomolecules on metabolism, immunity and the inflammatory conditions that are precursors to chronic diseases.
Examine the effect of functional foods and ingredients on health at all stages of life.
Determine the role of individuals’ genes in response to diet and their predisposition to metabolic diseases in a preventive context.
Study eating behaviours and the determinants of adopting healthy eating habits.
FOR AN INNOVATIVE BIOFOOD SECTOR

The three interest groups at INAF aim to increase research capacities and the economic spinoffs associated with Quebec’s major agri-food sectors. These include the milk and dairy products group, plant products and extracts group, and marine products and co-products group. These sectors have a high potential for innovation when it comes to food and ingredients. Through these interest groups, INAF collaborates closely with government departments, producers’ associations and numerous companies in these sectors to identify the research priorities associated with their specific areas of interest and to bolster their competitiveness.

MILK AND DAIRY PRODUCTS

The STELA Dairy Science and Technology Research Centre is central to this interest group’s activities. Researchers work to valorize milk and its components, develop concentration and separation technologies for milk components, tweak eco-friendly technologies and processes and study the functional ingredients of milk and milk products and their effects on health.

Among the recent findings for the fine cheesemaking industry include research on cheese ecosystems completed by Daniel St-Delais and Rémy Lambert. The research has served to establish a scientific basis and criteria for a reserved designation for cheeses made from Canadienne cow milk.

In addition, research led by Denis Roy and his collaborators have revealed the potential of probiotics to reduce the duration and frequency of upper respiratory tract infections, the use of antibiotics and absenteeism at work. Research by the NSERC-Novalait-DFC-PLQ-MAPAQ-Valacta Industrial Research Chair on Nutritional Control of Milk Components, directed by Yvan Chouinard, have resulted in improved technologies for the protection of polyunsaturated fatty acids to increase their proportion in milk’s total fat content. The research team is also working on preventing the deterioration of fatty acids by leveraging the transfer of antioxidant activity from different ration foods. Other research has also addressed the problem of biofilms in dairy product processing lines and optimizing the texture and functionality of yogurt, including research conducted by the teams led by Yves Pouliot, Alain Doyen, Sylvie Turgeon and Michel Britten.

INAF’S 3 INTEREST GROUPS

| Milk and dairy products | Plant products and extracts | Marine products and co-products |

INAF’s three interest groups aim to increase research capacities and the economic spinoffs associated with Quebec’s major agri-food sectors.
PLANT PRODUCTS AND EXTRACTS
The field of research on plants and plant extracts is vast and promising. Experts in this field are working to identify, enhance and exploit compounds from plant extracts to help prevent chronic diseases. As part of this objective, numerous clinical studies have been conducted, including several in collaboration with other major national and international centres.

An important project on the valorization of waste from certified organic fruits and vegetables was led by researchers Paul Angers, Joseph Arul, Yves Desjardins and André Gosselin. Together, they developed ways of extracting and processing this biomass to create extracts for use by the natural and nutraceutical products industry.

In terms of technology, expert on membrane separation Laurent Bazinet collaborated with Fruit d’Or to develop a way of deacidifying cranberry juice without significantly modifying its pH level, resulting in a drink that is both less bitter and still healthy. Pierre Haddad, director of the multidisciplinary CIHR Team in Aboriginal Anti-diabetic Medicines, is working with colleagues from other universities to identify and test medicinal plants and traditional foods that may help prevent and manage type 2 diabetes in four Aboriginal populations in Northern Quebec and British Columbia.

MARINE PRODUCTS AND COPRODUCTS
Researchers in this field have plenty of boldness and creativity when it comes to topics ranging from the identification of health benefits of molecules from marine sources, to recovering bioactive molecules from fisheries waste or to promoting the use of marine macroalgae in our diet.

Lucie Beaulieu’s team has produced an algae-enriched cheese to partially or totally replace the salt added during processing and extend its shelf life by leveraging the algae’s antifungal properties. Other work conducted by teams at Merinov and UQAR aim to promote the use of active compounds in microalgae, macroalgae, crustaceans and fish of commercial interest for the agri-food, health and sanitation sectors.

In addition, Hélène Jacques obtained partnership funding from MAPAQ and innoVactiv to conduct a clinical study on the effect of brown algae supplements on glucose metabolism in overweight individuals at risk of developing diabetes. Researchers Frédéric Calon and Mélanie Plourde are researching the protective effect of a diet rich in omega-3s (DHA) from marine sources against visual and spatial memory loss. Researcher Vincent Fradet is exploring whether a diet rich in omega-3 fatty acids can slow the progression of low-grade prostate cancer in patients under active monitoring and whether it could enhance the therapeutic effect of 5-alpha reductase in these patients. In patients with intermediate-to-high-grade prostate cancer, Vincent is examining the effects of an innovative supplement high in EPA (developed in partnership with SCF Pharma) on the growth rate of tumour cells, inflammation and patients’ quality of life.
OVERVIEW OF CURRENT RESEARCH THEMES

THE MICROBIOTA: A “VIRTUAL” ORGAN LINKED TO MANY METABOLIC DISORDERS

The intestinal microbiota is made up of all of the microorganisms in the digestive tract. Because of the microbiota’s impact on numerous physiological functions, some researchers call it a “virtual organ.” At INAF, work on the intestinal microbiota aims to shed light on the link between the microbiota’s active mechanisms and diet. A major scientific breakthrough was made by the team composed of Yves Desjardins, Denis Roy, André Marette and Emile Levy with a first pilot project that led them to pursue further research.

They discovered the ability of active compounds in cranberry polyphenols to stimulate the proliferation of an intestinal bacterium that may help prevent metabolic syndrome. The work was published in the prestigious journal Gut. A second pilot project paved the way for initial work on the gut-brain relationship with expert input from Frédéric Calon, associated with the CRCHU de Québec, and Sophie Layé, associated with INRA and Université Bordeaux. In addition, Ismail Fliss and his team revealed the impact of a pediocin-producing strain of lactic acid bacterium (Pediococcus acidilactici UL5) on the intestinal microbiota and L. monocytogenes using an in vitro human digestion model (Microbial Ecology).

By teaming up with competitive and leading-edge research centres, INAF uses its collaborative approach to position itself in developing poles of excellence like that of the microbiota.

André Marette,
INAF Scientific Director

This growing research field will benefit from the expertise of young researcher Alain Veilleux, who recently joined the FSAA School of Nutrition at Université Laval. Alain will conduct his work as part of the CERC program and focus specifically on the role of nutrition, the intestinal microenvironment and insulin resistance in postprandial dyslipidemia.
A MIXED APPROACH FOR BRAIN HEALTH

Another promising field of research at INAF is the impact of nutrition on brain health, including cognition, as well as normal aging of the brain and pathologies such as neurodegenerative and neuropsychiatric diseases. The excellence of this research pole at INAF has led to the creation of the OptiNutriBrain International Associated Laboratory, in collaboration with the NutriNeuro research team at Université de Bordeaux. Frédéric Calon (INAF) and Sophie Layé (Université de Bordeaux) are the directors of the laboratory.

The group supervised by Stephen Cunnane, from the Research Centre on Aging (Université de Sherbrooke), internationally renowned for his work in the field, is leading a controlled, randomized clinical trial as a proof-of-concept of the effectiveness of a therapeutic strategy that aims to offset energy deficiency of the brain by a ketogenic food supplement to treat Alzheimer’s disease.

Professor Charles Ramassamy, holder of the Louise and André Charron Research Chair on Alzheimer’s Disease, is also working to identify therapeutic molecules for the treatment of Alzheimer’s disease, such as polyphenols derived from plants and food. Researcher Guylaine Ferland (Université de Montréal), meanwhile, is studying the role of vitamin K in aging. She is specifically interested in the link between dietary intake of vitamin K and improved cognitive function in the elderly.

The work of Guy Rousseau (Université de Montréal) has shown us the detrimental effects of a heart attack which also affect the brain. The hypothesis is that inflammation caused by a reduced flow of oxygen to the heart during a heart attack plays a role in the subsequent depressive episodes observed in some patients. By reducing inflammation – through the administration of omega-3 metabolites, for example – a decrease in depressive behaviours was observed.
INTERVENTION STRATEGIES FOR THE ADOPTION OF HEALTHY EATING HABITS

In recent years, an increasing number of researchers at INAF have become interested in eating behaviours. They are specifically investigating the factors that play a leading role in eating habits and the transition to the adoption of healthy and sustainable behaviours.

Researchers are analyzing labelling, nutritional communication, blogs and articles on healthy eating, as well as psychological, social and environmental factors, to gain a better understanding of the factors that influence dietary choices and to establish improvement strategies. Researcher Simone Lemieux has brought together a team of experts in epidemiology, genetics, psychology, nutrition, metabolism and knowledge transfer as part of a CIHR research project on adherence to healthy eating recommendations, whose ultimate objective is to help Canadians adopt healthy eating habits. Her research has highlighted a difference between men and women, in regard to dietary intake and metabolic profile, over the course of a 12-week nutritional intervention promoting the Mediterranean diet (Journal of Nutritional Science).

Food Quality Observatory

As the fruit of an interdisciplinary working group from all regions of Quebec, the Observatory began its first research activities in 2016. Its objective is to observe and monitor the evolution of the food offer in Quebec. Thanks to the new methodologies and knowledge generated, this new platform is committed to serving as a lever for creating real improvements in both the quality and accessibility of Quebec’s food offer. Numerous INAF members are sharing their expertise, including Véronique Provencher, Laurélie Trudel, Simone Lemieux, Alexandre Lebel, Lyne Létourneau, Tony Savard, Rémy Lambert, JoAnne Labrecque, Sylvie Turgeon, Sonia Pomerleau and Mylène Turcotte.

“This arrangement would not have been possible without the concerted effort of multiple strategic partners and the financial support of Québec en Forme, the MSSS and MAPAQ. The Observatory’s vision spans local, national and international scales, and the well-established research network at INAF served as an efficient lever to quickly set up work at the Observatory.
Renée Michaud, INAF Executive and Development Director
ECO-EFFICIENCY FOR A SUSTAINABLE FOOD CHAIN

How do you generate more value with fewer negative impacts on the environment? Such is the question that underlies the research of numerous INAF researchers, such as Yves Pouliot, holder of the NSERC-Novalait Industrial Research Chair on Process Efficiency in Dairy Technology, backed by Quebec’s dairy industry and grouped under Novalait. This first major and collaborative initiative focusing on the integration of sustainable development in this industrial sector provides decision-making tools to dairy processors. The Chair, for example, has analyzed the environmental footprint of Greek yogurt according to three production methods to help processors make a sustainable production choice. The chair allowed for the hiring of a young researcher, Alain Doyen, whose expertise in membrane fractionation processes, hydrostatic pressurization technologies and efficiency optimization in the concentration and fractionation of dairy matrix components are a great benefit to the team.

With respect to energy-efficient food preservation, the team led by Mohammed Aïder has developed a new electro-activation in solution technology, integrated into a production process and pilot-tested for vegetable preservation. The technology allows for the production of products with a higher nutritional quality, without added salt, and energy savings of approximately 17%. Salwa Karboune and Valérie Orsat (U. McGill), for their part, are working on developing an innovative biocatalytic approach for the synthesis of indigestible phenolic oligosaccharides as functional and bioactive ingredients using by-products from the food industry.

FOOD SAFETY: A COMMITMENT TO CONSUMERS

Food and its bioactive components must not only be nutritious and beneficial to health, but they must above all be safe for consumption. The detection and control of pathogenic microorganisms is indispensable to ensuring that food is safe and high quality.

Many options and innovative control strategies are studied at INAF using molecular approaches to the detection, attachment, persistence and inactivation of pathogenic microorganisms (Julie Jean), as well as the identification of new, natural preservation agents (Linda Saucier, Monique Lacroix). In this respect, research being completed by the team led by Ismail Fliss is focusing on the antimicrobial potential of bactericins and lactic acid bacteria. The team has worked in collaboration with Grizzly Smokehouse and successfully tested a product that extends the preservation period for sliced, ready-to-eat smoked salmon.

The results produced by the chair allow us to take a critical look at our technological choices and their influence on the eco-responsible development of our industry. In my opinion, one of the greatest strengths of this project is the direct connection of researchers and their students to industry stakeholders, which ensures that the research remains relevant. Its other undeniable strength is the quality of the students trained. The next generation will be highly qualified to tackle the challenges of tomorrow.

Pierre Morin, R&D Director
Agropur Cooperative, Chair partner
More recently, INAF has added food risk analysis, food quality and safety regulation, and allergen control to its portfolio of expertise. Under the supervision of Samuel Godefroy, researchers are evaluating the prevalence and risks for consumers of allergens in processed foods, as well optimizing and validating detection methods. Samuel Godefroy is also leading initiatives focusing on the development of skills related to food safety and regulatory policies in China, Southeast Asia and the Middle East.

THE "OMIC" SCIENCES: ON THE PATH TO PERSONALIZED NUTRITION

At INAF, the "omic" sciences are used in multiple disciplines and have expanded research horizons by making it possible to globally measure the molecular processes involved in food processing and disease etiology. Nutrigenomics and epigenetics will be specifically critical to the development of application and knowledge transfer strategies related to personalized nutrition. Research being conducted by Marie-Claude Vohl, Louis Pérusse and Julie Robitaille has made it possible to identify environments and individuals at a genetic risk, as well as to recommend healthy diets adapted to specific individuals, such as pregnant women, athletes and the elderly.

In the field of reproductive biology, research completed by Marc-André Sirard and Claude Robert has resulted in the development of a unique database on gene expression in the ovaries, ovum and the young embryo. The integration of this information has become a reference in the pursuit of further work, specifically on the impact of the mother’s nutrition and metabolic status on the embryo. The research also aims to gain a better understanding of environmentally induced epigenetic programming that may influence gene expression in adults.

Researcher Steve Labrie, funded by Genome Canada in partnership with the Agropur dairy cooperative, is also using genomic tools to study the microbial flora that develops during the cheese aging process. Understanding the diversity and evolution of microbial ecosystems has been greatly improved due to the use of “-omic” tools such as (meta)genomics and (meta)transcriptomics.

INAF has added food risk analysis, food quality and safety regulation, and allergen control to its portfolio of expertise.
OUR PLATFORMS AND SERVICES: ESSENTIAL LINKS TO RESEARCH AND INNOVATION

INAF opens the door to a vast network of experts and services to support the successful completion of research projects. Our multidisciplinary platforms aim to make proven technologies available and to share knowledge with the goal of making research more efficient.

IN VITRO AND IN VIVO PRECLINICAL STUDIES

INAF is equipped with an in vitro digestion platform, including a dynamic digestion simulator (TIM) and a colonic fermentation model, as well as a range of cell and animal models to analyze bioavailability, inflammation, diabetes, obesity and Alzheimer’s disease, among others.

Recent studies on the intestinal microbiota have upended the vision of the link between food and health. To adapt to this evolving field, new metagenomic tools and tools for measuring intestinal permeability, as well as overall digestive health, have been developed. Between 2012 and 2016, the in vitro digestion platform completed 26 projects and 18 others utilized the cell and animal models available.

SERVICES AVAILABLE

- IN VITRO and IN VIVO preclinical studies
- Clinical studies
- Analytical services
- Clinique Nutrition Santé
- Innovation Support Services
INAF’s clinical investigation unit is comprised of numerous installations and state-of-the-art equipment allowing for multiple research projects to be completed at once. The only one of its kind in Canada, the infrastructure can be used to complete every stage of a nutritional intervention study. Between 2012 and 2016, 40 studies were completed, including:

Among these projects, five multicentre projects were completed with other research establishments, several of which were completed with industry partners. Collaborators included research establishments in Canada (U. of Manitoba, U. of Toronto), the United States (Penn State U.) and France (Institute of Cardiometabolism and Nutrition, French National Institute for Agricultural Research (INRA), Université de Bordeaux).

In total, approximately 30 INAF researchers were involved in these multidisciplinary projects that called on the expertise of nutritionists, physiologists, chemists, pharmacists, medical doctors, epidemiologists, psychologists and food science specialists.

INAF’s researchers have developed multiple information technology tools, including a 24-hour reminder for diet evaluations and FANI (Functional Application of Nutrition on Internet), an online platform for managing nutritional clinical studies. FANI allows researchers to coordinate, using the internet, an entire nutritional research project, including randomization, follow-up with participants, questionnaire management, data collection and diet evaluations. The arrival of these systems has significantly improved data reliability as well as efficiency by reducing the total work time. Access to the study’s data is also centralized, which facilitates data processing in the case of multicentre studies.

**CLINICAL STUDIES**

- Six controlled and randomized studies (participants’ diet is controlled while providing all meals for periods ranging from several weeks to several months);
- Four partially controlled studies (certain foods or meals are provided to participants);
- Eleven studies using supplements (such as omega-3 capsules and enriched beverages); and
- Three studies on modifying eating behaviours.

**Our Platforms and Services**

- 24 nutritional intervention studies
- 9 epidemiological studies / cross-sectional studies / nutritional surveys
- 7 studies focused on, for example, testing nutritional tools, dietary questionnaires and assessing perceptions, beliefs and eating behaviours.

**CLINICAL INVESTIGATION UNIT (2012 TO 2016)**

- 3,197 participants
- 8,204 visits to the blood test centre
- $400,000 in food
ANALYTICAL SERVICES

Each year, INAF professionals provide services for the identification, assay and characterization of more than 150 types or categories of molecules. They have an impressive inventory of state-of-the-art equipment at their disposal, allowing them to adapt analysis protocols to users’ needs.

Between 2012 and 2016, INAF researchers processed nearly 650 analysis requests for researchers, students and industry partners. The primary molecules studied included polyphenols, peptides and lipids. During this period, new analytical equipment was also acquired, including spectrometers.

Most of the requests arose from research projects involving INAF members. Requests from external researchers, companies and organizations in the sector made up nearly 40% of the volume of activity completed.

CLINIQUE NUTRITION SANTÉ

Clinique Nutrition Santé provides private nutritional counselling to the general public and completes more than 450 individual consultations each year. Nutritionists focus on weight problems, eating behaviours and cardiovascular health. In 2015, a social worker specialized in these areas joined the team and a partnership was established with the Laboratory on Weight and Eating-Related Problems. The clinic’s new multidisciplinary team, supervised by Catherine Bégin, provides individual psychosocial and nutrition consultations, in addition to leading support and therapy groups on binge-eating disorders.
INNOVATION SUPPORT SERVICES

Through collaborations with INAF’s Innovation Support Services, supervised by Steve Labrie and Alain Doyen, companies emphasized the development of healthy and nutritious products due to their direct access to a large network of multidisciplinary experts. In total, companies and organizations invested nearly $1.6 million to support innovation in the health food and ingredients sector. Three-quarters of the companies were located outside of the Greater Quebec City region. More than half were SMEs, the rest being equally distributed between large companies and startups. Their activities range from the plant products sector (26%), to bakery products (17%), dairy products (11%), meat and marine products (10%), food services (10%) and, to a lesser extent (<10% each), ingredients, maple syrup products, candy and natural health products.

From 2012 to 2016, ISS continued its growth trajectory and successfully undertook more than 60 mandates.

MAKING THE GROUP SHINE

An experienced team of professionals contributes to developing, managing and enhancing the Institute’s influence. They support researchers in their projects in partnership with the community, lead the way in organizing events and strengthen the group’s cohesion while ensuring its prosperity.
INTERNATIONAL AGREEMENTS AND PROJECTS: COMING TOGETHER FOR RESEARCH WITHOUT BORDERS

Collaboration between experts in the field and from diverse backgrounds creates a dynamic work environment at INAF and leads to increased international recognition of its expertise. INAF’s high standards for precision and creativity, as well as the importance it places on its collaborators’ expectations, have made the Institute a key partner in the health and nutrition sector in Canada, and throughout the world.

FRANCE

A natural choice for developing new collaborations and increasing INAF’s renown, projects have been launched in conjunction with numerous institutions in France.

UNIVERSITÉ DE BORDEAUX

By founding INAQ (Institut de nutrition Aquitaine-Québec) in 2009, INAF and the Institut de Recherche en Nutrition Humaine d’Aquitaine at Université de Bordeaux (INRHA) built on the complementary expertise of their respective members in the field of nutrition and its impact on health in the context of aging populations. After years of research and knowledge transfer activities, the establishment of the Neurophenols project is a concrete example of the partnership’s strength and scope.

Neurophenols Consortium

One of INAF’s keystone projects, the Neurophenols Consortium brought together scientists from both sides of the Atlantic in the fields of phytochemistry, neuroscience and nutrition, as well as companies specialized in the development of active ingredients and food supplements. Participating INAF researchers include Frédéric Calon, Yves Desjardins, Charles Ramassamy and Catherine Bégin. Between 2012 and 2015, more than 30 professionals took part in this major undertaking endowed with a budget totalling more than 4.2 million euros. The project concerned the characterization of blueberry and grape extracts, as well as the assessment of their safety and effectiveness in preventing age-related cognitive decline through preclinical and clinical trials. The active berry extracts developed by the researchers are used in the preparation of food supplements now available on the market. The Neurophenols Consortium was awarded the Agrimip award by Agri Sud-Ouest Innovation – a competitive cluster for the agriculture and food industries – recognizing a collaborative scientific, technological and industrial project.

SPINOFFS FROM THE NEUROPHENOLS PROJECT

- Completion of a large-scale, multicentre clinical study (>200 participants) on two continents
- Filing of two patents (France and the United States)
- Development of new analysis methodologies
- Diversification and positioning of finished products by industry partners
- Identification of new biomarkers
- Training of PhD candidates
- Obtaining of a market release and product marketing licence by partners
OptiNutriBrain International Associated Laboratory

In 2014, the Neurophenols Consortium evolved into the OptiNutriBrain international associated laboratory (IAL). The laboratory is a joint initiative of Université Laval (INAF), Université de Bordeaux, the Institut National de la Recherche Agronomique (INRA) and the Institut National Polytechnique de Bordeaux (INP). OptiNutriBrain is an international leader in the high-priority domains of nutrition and brain health. Given our aging populations, research on nutrition and brain health is quickly becoming essential. Co-supervised by professors Sophie Layé (INRA, Université de Bordeaux) and Frédéric Calon (CHUQ and INAF), a professor in the Faculty of Pharmacy at Université Laval, they are able to rely on INAF’s vast network of researchers and the NutriNeuro laboratory in Bordeaux. The IAL is an exclusive portal for collaboration between scientific researchers and international industry partners, as well as for the recruitment of graduate students. In this respect, Hortense Phanet was the first student to complete a doctoral thesis inside OptiNutriBrain. She is jointly supervised by Frédéric Calon (INAF) and Sylvie Vancassel (Université de Bordeaux).

Launching of OptiNutriBrain IAL, November 2015
From left to right: Jean Dallongeville (INRA), Sylvie Turgeon (INAF), Denis Bréère (ULaval), Sophie Layé (INRA), Frédéric Calon (INAF), Rémi Quirion (FRQ), Pierre Dos Santos (INP) and Nicole Lacasse (ULaval).

UNIVERSITÉ DE LILLE 1

In April 2016, the IAL in natural antimicrobials (LIAAN) was launched in partnership with the agri-food and biotechnology regional research laboratory, the Institut Charles Violette at Université de Lille 1. LIAAN is an international leader in the bioproduction of natural antimicrobials through the bioprospection, production and exploitation of antimicrobial molecules. Research completed at the laboratory will lead to the development of new applications in the food, medical and veterinary sectors. The INAF researchers behind LIAAN are Laurent Bazinet and Ismail Fliss, professor-researchers in the FSAA Department of Food Sciences at Université Laval. Their counterparts at Université de Lille are professor-researchers Pascal Dhuister and Djamel Drider.

EUROPEAN CENTRE FOR NUTRITION AND HEALTH (CENS) - LYON

In 2015, an agreement was signed between Université Laval and Université de Lyon involving INAF and its counterpart, CENS. The goal of the framework agreement is to intensify research collaborations, exercise leadership in the development of scientific projects and promote student and researcher mobility. The main themes targeted include the prevention of obesity and cardiometabolic diseases through nutrition. Research related to the study of eating behaviours and the culinary sciences also involves Institut Paul Bocuse in Lyon, France. Cécile Vors is the first post-doctoral researcher to be welcomed at INAF, in the laboratory of Benoît Lamarche, since the signing of the agreement. The international consortium NutriBiota – bringing together researchers from Belgium, France and INAF – also aims to gain a better understanding of the role of the intestinal microbiota.

International collaborations provide access to large research teams. These exchanges make us more effective at attaining our objectives and enhancing our international reputation. Pooling our expertise also provides access to more funding and new expertise.

Yves Desjardins, Director of International Affairs
THE NETHERLANDS

By signing a collaboration agreement with Maastricht University in 2014, INAF joined together with one of the largest international leaders in nutrition innovation. Maastricht University is renowned for two of its programs that are at the forefront of the agri-food sector: a multi-faculty master’s program in health food innovation management and a School of Nutrition and Translational Research in Metabolism. The objective of the partnership is to establish a sustainable base for long-term collaboration in the fields of nutrition, medicine, psychology, entrepreneurship and innovation, and to provide opportunities to researchers and students to complete research at the two partner universities.

To date, the alliance has resulted in the development and integration of an innovation internship component in the food sciences master’s program at Université Laval. Five students from Maastricht University have also completed six-month internships at INAF within the scope of their studies in agri-food innovation management, with collaboration from INAF’s Innovation Support Services and private companies in Quebec. Interns have completed projects with the Gosselin Group on edamame cultivation, with Boulangerie St-Méthode on consumer perception, and on health claim documentation with the Lassonde Group.

MEXICO

INAF has been collaborating with different research centres and universities in Mexico for a number of years. The many projects completed led to the signing, in 2012, of a collaboration agreement between INAF and the State of Jalisco to promote mobility among professors and students, which has already proved fruitful. Cristina Ratti, Linda Saucier and Frédéric Calon led projects in collaboration with the University of Guadalajara and ITESCO. The collaborations have given rise to eight publications and scientific presentations at international conferences, as well as the co-supervision of two master’s and PhD students. PhD student Jorge Castro Albarran notably obtained a grant from the Canadian government as part of the Emerging Leaders in the Americas program for a six-month internship at Université Laval. Arianna Chan from the Centro de Investigacion Científica de Yucatan also completed a six-month internship as part of the same program. Her project focused on characterizing carotenoid content of unique accessions of papaya from the Yucatec forest. INAF has also established a close collaboration with CIATEJ in Guadalajara, a CONACYT centre specialized in food technology and which is increasingly involved in research on human health. The collaboration recently obtained major funding from the PSR-SIRI program to develop a new symbiotic product composed of polyphenol extracts from berries and fructo-oligossacharides from agave.
INAF Activities Report 2012-2016

PUSHING RESEARCH FRONTIERS

INAF is a distinguished training ground and research institution that attracts researchers from research centres all over the world. The internationally renowned expertise of our researchers opens the door to international stays at world-class institutions to develop and share their knowledge.

The following researchers have recently completed international stays at the following research centres:

Joseph Arul completed a research stay at Karunya University (India) to identify new plant-based antimicrobial sources. Julie Jean expanded her knowledge of food microbiology during her stay in Switzerland (WHO and Nestlé R&D Centre). Hélène Jacques studied the effects of consuming low-fat marine products on cardiovascular risk at the National Institute of Nutrition and Seafood Research (Norway). A stay in Nantes, France, provided Julie Robitaille with the opportunity to study the effects of fetal programming (epigenetic) on children’s health. Lastly, in the field of neuroscience, Charles Ramassamy completed two stays in France (Université de Rennes 1 and Université de Lorraine) to develop his expertise on the antioxidant potential of polyphenols and their encapsulation by nanoparticles. In return, numerous visiting professors were welcomed by INAF researchers.

RESEARCHERS INVITED TO INAF

2013

Anie Day, Philippine Atomic Energy Commission, Philippines
Laboratory directed by Monique Lacroix (food sciences, INRS-Institut Armand-Frappier); Development of biopolymers with antioxidant properties.

Vanina Martinez, INTI-Quimica, San Martin, Argentina
Laboratory directed by Cristina Ratti (agri-food engineering); Project on encapsulating flaxseed oil. The research results were presented at the IUFOS conference in August 2014.

2014

Didier Buisson, Museum of National History of Paris (CNRS), France
Laboratory directed by Ismail Fliss (microbiology); Study of microcin J25’s gastrointestinal conduct and stability and its anti-salmonella activity using INAF’s in vitro digestion platform.

Ghislain Garrait, Biopharmaceutics Laboratory, Université d’Auvergne, France
Laboratory directed by Muriel Subirade (food chemistry); Research on interactions between food components and active ingredients.

2015

Mercedes Lopez, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mexico
Laboratory directed by Yves Desjardins (plant chemistry); Effect of polyphenols and fructanes on the intestinal microbiota and basal inflammation.

Emmanuel Moyse, Université François Rabelais de Tour, France
Laboratory directed by Charles Ramassamy (neuroscience, INRS-Institut Armand-Frappier); Study on caloric intake and gene expression during aging. The research led to a scientific publication.

2016

Mauro Sola-Penna and Patricia Zancan, Laboratório de Enzimologia e Controles do Metabolismo, Universidade Federal do Rio de Janeiro, Brazil
Laboratory directed by André Marette (diabetes); Role of the iNOS enzyme and phosphatase SHP-1 in the development of insulin resistance.

Zhanyong Guo, Université de Sezhuan, China
Laboratory directed by Monique Lacroix (food sciences, INRS-Institut Armand-Frappier); Development of chitosan-based antimicrobial bioactive polymers.

Lei Qian, East University of Heilongjiang, China
Laboratory directed by Stan Kubow (nutrition, McGill University); Study on the bioprocessing of polyphenols and anthocyanins using an in vitro digestion model.
More than 400 graduate students are refining their skills and knowledge in INAF’s research environment.

STUDYING AT INAF:
A SPRINGBOARD FOR SUCCESS

Every year, more than 400 graduate students work to refine their skills and knowledge in INAF’s research environment. The unique training that INAF provides is a combination of excellent academic supervision and a rich scientific events program. INAF’s interdisciplinary character gives students the opportunity to address research problems at the interface of the pure sciences and engineering, the health sciences and the social sciences.

The inter- and trans-disciplinary nature of our work allows students to collaborate with professionals and student colleagues in the fields of nutrition, chemistry, engineering, food science, microbiology and pharmaceuticals.

The Institute’s notoriety has attracted an increasing number of foreign students to complete graduate studies or internships in our teams. The many framework agreements with research centres and universities facilitates mobility within the INAF network, as well as internationally, in addition to giving rise to enriching inter-laboratory exchanges for students.

Distribution of students according to theme

- THEME 1 - Identification and characterization: 18%
- THEME 2 - Technologies and processes: 53%
- THEME 3 - Nutrition and health: 29%

Number of students enrolled in graduate studies

- Postdoctoral fellows: 29%
- PhD: 53%
- Master’s: 18%
INAF Activities Report 2012-2016

AN ENVIRONMENT THAT INSPIRES AND PROMOTES EXCELLENCE

INAF makes every effort to help its members recruit high-calibre students for their research teams. In fact, 20% of INAF’s students have received excellence grants from numerous programs and organizations.

Thanks to the FRQNT Strategic Clusters grant, the Institute is able to provide the means to facilitate access to graduate studies. Between 2012 and 2016, 30 new students began graduate studies thanks to grant supplements ($75,000 total) and 110 others received travel grants to present their research results at large international conferences in their respective fields ($55,000). A dedicated fund also made it possible for three of our PhD students to complete research internships in France.

STUDYING AT INAF

Three INAF students have received Banling and Best fellowships: Lydi-Anne Vézina-Im (2013), Hubert Cormier and Thomas Grenier-Larouche (2014). The grant provides financial support to exceptional students enrolled in a graduate study program.

INAF has proven itself as a centre of excellence for students from many countries who aim to complete transdisciplinary studies in connection with current needs.

Sylvie Turgeon, INAF Director

20% of INAF students have received excellence grants.
AN IN-DEMAND TRAINING ENVIRONMENT

The rich scientific events program established by INAF provides students with numerous opportunities to increase their knowledge of topics outside of the scientific realm, including societal and industry issues. They have access to networking activities with the industry as well as an annual conference program that showcases the work of renowned researchers. Students are also invited to play a key role in the organization of scientific events, providing them with the unique opportunity to develop their organizational abilities, communication skills and project management skills, all of which are transversal skills that future employers are looking for.

OUR STUDENT RESEARCHERS: FUTURE DRIVERS OF INNOVATION

The learning environment at INAF provides students with employment prospects that are as relevant as they are diverse. More than 90% of the students trained by INAF’s member researchers obtain jobs in their field. Our industry graduates land positions at both SMEs (Fruit d’Or, Colarome, Biena, for example), and large companies (including Lassonde, Agropur, Ultima, Saputo, Leclerc, Lallemand, Liberté, Nestlé, Danisco, Parmalat, ADM and Kraft).

Student involvement in INAF events provide a golden opportunity to meet major actors in the sector and future employers. Above, a group of students gather at BÉNÉFIQ 2012.

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Students play a key role in the organization of scientific events while developing transversal skills.

A study completed on our student body between 2012 and 2013 provided us with a profile of our students post graduation:

- **45%** occupy R&D positions in the university and hospital sectors, the food industry or in the biomedical/biotechnologies and agricultural sectors.
- **10%** occupy positions as university professors or teaching assistants in no less than 11 different countries.
- **10%** occupy positions as specialists, analysts or project managers in federal government and provincial departments (MAPAQ, MSSS, INSPQ, CFIA, Health Canada) or in industry (agri-food, biomedical or finance).
- **20%** continued their master’s degree studies at the PhD level, with some moving on to post-doctoral fellowships.

SOME OF OUR GRADUATES WITH AN ENTREPRENEURIAL BENT HAVE DEVELOPED THEIR OWN COMPANIES BASED ON THE EXPERTISE ACQUIRED DURING THEIR PHD

- **Karine Gravel**
  Nutrition consultant and blogger

- **Mariana Royer**
  Bio ForeXtra Laboratories Inc.

- **Romain Caillard**
  BioVelia

STUDYING AT INAF

The 2016 Students Symposium resulted in more than 20 student presentations, four sessions by invited researchers, a poster session and a networking activity.
Between 2012 and 2016, 32 INAF students received FAST scholarships for a total of $600,000.

THE FAST PROGRAM – A LEADERSHIP INCUBATOR

The Food Advancement through Science and Training program (FAST) is both a scholarship program and a high-level interdisciplinary advanced development platform. It focuses on the acquisition of transversal skills, the completion of internships and networking with professionals in the field. The program was created in 2010 in collaboration with the University of Manitoba, with funding through NSERC and the Collaborative Research and Training Experience Program (CREATE). FAST prepares students to meet the demands of the labour market in the health food sector, which often go beyond research training and concern regulations, markets, communication, innovation, and project and team coordination. The FAST program is managed by a committee made up of members from academia, industry and government working in the agri-food and health sectors.

Students from INAF and the University of Manitoba jointly organized three scientific symposiums presented in Winnipeg in 2012 and 2014, and at INAF in 2016. The symposiums were a great success, drawing approximately 40 students and 60 professors and partners at each edition.

The program’s second major event is the FAST Summer School, an intensive session of interactive workshops addressing concrete issues in the sector. More than 125 graduate students took advantage of this exclusive training.
KNOWLEDGE TRANSFER: SHARING AND DISSEMINATING KNOWLEDGE

INAF is committed to organizing regional, national and international events for the benefit of a range of groups, including scientists, health professionals, industrialists and the general public. These knowledge transfer activities are organized to deliver and increase research impacts. They aim to offer concrete solutions to the bio-food industry, as well as to health professionals and political decision-makers. Many of these events are now held regularly and serve as networking opportunities for these different target groups.

UNITING PROFESSIONALS AND SPREADING KNOWLEDGE

BÉNÉFIQ 2012 AND 2014

BÉNÉFIQ is the international rendezvous on health ingredients, a biannual event combining science with business. The conference offers scientific sessions, marketing and innovation sessions, an innovation showcase, a tech transfer zone and a platform for business meetings. More than 500 key actors participated in each of the first two editions. Hundreds of business meetings, as well as new partnerships established during the first two editions, created impetus for a third edition held in October 2016. Renée Michaud and Paul Paquin are the instigators of this flagship event.

PROBIO 2013 AND 2015

The Probio Symposium is organized by the Association for Health Ingredients in Food (AHIF), in collaboration with INAF. The 2013 edition, with the theme of intestinal health, brought together more than 200 individuals from the health and nutrition sectors who came to discuss and learn about the latest scientific advancements.

In 2015, the organizers added an evening open to the public showcasing the “Pharmachien,” the popular pharmacist, and chef Jean Soulard. Mr. Soulard gave a cooking demonstration on preparing meals that integrate probiotics. The event saw overwhelming success that surpassed organizers’ expectations, with more than 600 participants attending.

2013 AND 2015 STELA SYMPOSIA

The biannual conference organized by the Dairy Science and Technology Research Centre (STELA) has established itself as an event that’s not to be missed in Quebec’s dairy sector. Over the course of two days, nearly 200 researchers, students, industrialists and government representatives met to present and discuss research innovations and future challenges.

The 2013 edition was organized jointly with the Canadian chapter of the International Dairy Federation (IDF) and was spread out over four days. In 2015, the theme of “Challenges and Opportunities for the Dairy Sector” was addressed in presentations on energy efficiency in food processing, milk composition in relation to cow diet, obesity and the relationship between dairy product consumption and high blood pressure.
HEALTH INGREDIENTS, TECHNOLOGY AND NUTRITION SYMPOSIUM

Organized in 2014 in collaboration with the Centre québécois de valorisation des biotechnologies (CQVB), a symposium focusing on health technologies, health ingredients and nutrition, provided an opportunity to showcase the next generation in training at INAF. Students and interns presented their research projects to industry partners interested in nutrition innovation, food processing and the health benefits of certain food components.

fast
INNOVATOR
FAST INNOVATOR

In the spring of 2015, with funding from MAPAQ, MEIE and Emploi Québec, INAF established FAST INNOVATOR, an advanced development and customized support pilot program for SMEs in Quebec’s food industry. The training saw remarkable success with the participation of more than 13 companies (60 participants) seeking to increase their competitive edge through innovation. Throughout the training, companies conducted an extensive business self-evaluation using the DiagnoSTIQ Innovation tool. During a special marketing event organized by the Conseil de la transformation alimentaire du Québec (CTAQ) on November 25, 2015, an excellence award in food innovation was awarded to the company Fruit d’Or recognizing its exceptional performance during the exercise. The FAST INNOVATOR pilot program has served as the foundation for a provincial-wide project focusing on supporting innovation (Programme d’accompagnement en innovation ouverte (PAIO)), now led by the CTAQ, the INITIA Foundation and AgBioCentre.

EVENT AND CONFERENCE ORGANIZATION

INAF researchers are actively involved in the organization of national and international scientific conferences.

Laurent Bazinet
FSAA, Université Laval
Congrès Adébiotech-Société Française de génie des procédés (SFGP) October 2012, Paris Member of the Scientific Committee 17th International IUFoST Conference August 2014, Quebec City Member of the Scientific Committee and theme leader Nutrevent June 2015, Lille Member of the Scientific Committee Member of the Nutriawards jury

Frédéric Calon
Faculty of Pharmacy, Université Laval Annual conference of the Association of Faculties of Pharmacy of Canada June 2012, Quebec City President of the Organizing Committee

Samuel Godefroy
FSAA, Université Laval AQIA Symposium October 2015, Quebec City Program Committee member China International Food Safety and Quality Conference November 2015, Beijing Panel moderator on regulations

Julie Jean
FSAA, Université Laval AQIA Symposium 2012 to 2015, Quebec City Program Committee member

Monique Lacroix
Institut Armand-Frappier, INRS 10th Meeting of the Ionizing Radiation and Polymers Symposium (IRAP 2012) October 2012, Poland Member of the Organizing Committee

COFERENCE ORGANIZATION

EVENTS

CONFERENCES

Martin Mondor
Agriculture and Agri-Food Canada
Cristina Ratti
FSAA, Université Laval
Khaled Belkacemi
FSAA, Université Laval
Sébastien Villeneuve
Agriculture and Agri-Food Canada

12th International Congress on Engineering and Food (ICEF12) June 2015, Quebec City Members of the Organizing Committee

Martin Mondor received the Distinguished Service Award for his involvement.

Linda Saucier
FSAA, Université Laval
International Congress in Meat Science and Technology August 2012, Montreal Co-president

Congrès de l’Ordre des agronomes du Québec October 2015 St-Alexis des Monts, Quebec Member of the Organizing Committee

Marie-Claude Vohl
FSAA, Université Laval
7th Congress of the International Society of Nutrigenetics/Nutrigenomics (iSNN) October 2013, Quebec Member of the Organizing Committee

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COMMUNICATING SCIENCE TO THE PUBLIC

CAMP ALIMENT’TERRÉ

In 2014, INAF spearheaded Camp Aliment’Terre, a day camp for youth ages 10 to 12. With an actual food processing laboratory at their disposal, the camp took the children on a culinary, sensorial and scientific adventure as they discovered food from new perspectives, garden-to-plate.

Find out more, Watch the video [in French only]

The first edition was awarded a DUX award which recognizes initiatives contributing to improving healthy eating habits. Chef Jean Soulard, researcher Simone Lemieux and nutritionists Anne Deslauriers and Vicky Leblanc were the masterminds behind the proposed activities. Some of the activities were organized in collaboration with staff from the food processing laboratory and FSAA’s Van den Hende Garden, helping to make the camp a success.

EAT, DRINK AND MOVE... FOR YOUR HEALTH!

In 2015, 450 people participated in the event “Manger, boire, bouger... en mode santé!” open to the general public. The activity was organized by INAF in collaboration with Université Laval’s International Chair on Metabolic Risk, supervised by Jean-Pierre Després and Alliance Santé Québec. Participants were able to visit 25 exhibitor booths on nutrition, health and physical activity, and attend a presentation and discussion with experts in nutrition and cardiovascular health on the impact of lifestyle habits on disease prevention.

BOOK PUBLICATIONS

In addition to participating in the writing of numerous popular science articles, some INAF researchers and graduate students are also authors who have enjoyed success with the general public. Here are the titles of their most recent publications:

Légumineuses & Cie, Ma Table Festive, Non coupable and À bas les kilos!, by Hubert Cormier, nutritionist and INAF PhD student.

Volumes 1, 2 and 3 of the food encyclopedia: Tout sur les légumes, Tout sur les fruits, les noix et les graines and Tout sur les viandes, les poissons et les fruits de mer, by a group of INAF professionals, in partnership with the Académie Culinaire and Éditions Québec-Amérique.

La vérité sur le sucre, by André Marette, professor-researcher and INAF’s scientific director, in collaboration with Dr. Geneviève Plion, INAF research professional.

Le Soulard des Sportifs, by Benoît Lamarche, an INAF member, professor-researcher and former Olympic athlete, in collaboration with chef Jean Soulard.

Lundi, je me mets au régime!, by Judith Petitpas, social worker at INAF’s Clinique Nutrition Santé.

La réduction du sel dans les fromages, by Steve Labrie and Paul Paquin, INAF researchers, published in association with the International Dairy Federation.
A MARKED MEDIA PRESENCE

Researchers help to disseminate knowledge among the general public through media appearances. Here are a few examples:

Steve Labrie, director of the Food Mycology Laboratory and INAF researcher, was invited to La nature selon Boucar broadcast on Radio-Canada Première. He provided insights into yeasts, those little-known organisms, and taught us about the many unsuspected services they provide.

The blog post entitled Perdre du poids et de la dignité, by INAF researcher and nutritionist Simone Lemieux, was selected to appear along with 50 other blog posts in the 2nd edition of “Les meilleurs blogues de science en français” [The Top French Science Blogs], published in spring 2014 by Science-Presse at Éditions MultiMondes.

Strawberries from Île d’Orléans could help prevent type 2 diabetes. The host of the Radio-Canada radio show Bien dans son assiette invited Hélène Jacques, professor-researcher from the School of Nutrition and INAF member, to learn more about the research results.

Researchers André Marette, from INAF, and Patrice Cani, from Université de Louvain in Belgium, demystified the concept of the intestinal microbiota and its impacts on obesity and type 2 diabetes during a special edition of Découverte à Radio-Canada.

PhD student Marie-Hélène Lessard presented her research project on the ecosystem of surface mold-ripened soft cheese during the weekly radio show Les années lumière, on Radio-Canada, hosted by Yannick Villedieu.

Numerous INAF researchers help to disseminate and make information on healthy eating habits, as well as research in the field, accessible to the general public. Among other outlets, they share their opinions and knowledge on the Web. Here are a few examples:

• Hubert Cormier and Audrey-Anne Dumas address food-related subjects on their respective blogs;

• Stéphane Bayen shares discoveries related to food contaminants on the Food Toxicants Laboratory website;

• Samuel Godefroy manages a blog on food science and its regulatory aspects;

• The Food Mycology Laboratory, directed by Steve Labrie, has set up a Facebook page, another platform type, that gets research out of the lab and into the public domain.

FOOD SCIENCE IN THE DIGITAL AGE

More than 500 news articles have been published on INAF’s website since 2012. The articles are also shared on social media accounts managed by INAF, including LinkedIn and Twitter. Continue following us to stay up-to-date on the latest news from INAF.

Simone Lemieux, a nutritionist, INAF member and professor at the School of Nutrition, has maintained a blog on nutrition since 2013. Her blog aims to stimulate discussion on hot topics in nutrition, for example, our view of obesity and people who suffer from it, our attitudes as parents in relation to our children’s diet, our sometimes complex and conflicted relationship with food, and many more.
LIST OF ABBREVIATIONS

ACCORD Clusters of Excellence
Based on specific recognized skills, the ACCORD regional “clusters of excellence” were introduced to develop a brand image for each region of Quebec and to ensure that they receive wide exposure both nationally and internationally.

ACFAS
Association francophone pour le savoir

AQIA
Association québécoise pour l’innocuité alimentaire

CENS
European Centre for Nutrition and Health

CFI
Canadian Foundation for Innovation

CHUQ
CHU de Québec

CIATEJ
Centro de Investigacion y Asistencia en Tecnología y Diseño del Estado de Jalisco

CIHR
Canadian Institutes of Health Research

CONACYT
Consejo Nacional de Ciencia y Tecnologia

CRCHUQ
Centre de recherche du CHU de Québec

CREATE
Collaborative Research and Training Experience Program

CRIBIQ
Consortium de recherche et innovations en bioprocédés industriels au Québec

CTAQ
Conseil de la transformation alimentaire

FAST
Food Advancement through Science and Technology

FRQNT
Fonds de recherche du Québec – Nature and Technologies

FRQS
Fonds de recherche du Québec – Health

FSAA
Faculty of Agriculture and Food Sciences, Université Laval

IAL
International Associated Laboratory

INRA
National Institute for Agricultural Research (France)

INRS
Institut national de la recherche scientifique

ITESCO
Instituto Tecnologico y de Estudios Superiores de Occidente

IUFoST
International Union of Food Science and Technology

MAPAQ
Ministère de l’Agriculture, des Pêcheries et de l’Alimentation du Québec

Mitacs
Mitacs is a national non-profit organization that has designed and implemented research and training programs in Canada for more than 15 years.

MEIE
Ministère de l’Économie, de l’Innovation et des Exportations (from April 2014 to January 2016)

MESI
Ministère de l’Économie, de la Science et de l’Innovation (beginning January 2016)

MSSS
Ministère de la santé et des services sociaux du Québec

NSERC
Natural Sciences and Engineering Research Council of Canada

NUTRINEURO
Mixed Research Unit, INRA, Bordeaux

Prix DUX
Addressed to both the public and private sectors, DUX is the first contest that honours, celebrates and promotes initiatives that inspire Canadians to eat better and live better.

PSR-SIIRI
Programme de soutien à la recherche – Soutien à des initiatives internationales de recherche et d’innovation (MESI program)

MRU
Mixed Research Unit

STELA Centre
Dairy Science and Technology Research Centre

UQAR
Université du Québec à Rimouski