Canadian Microbiome Initiative

Workshop Report

CIHR IRSC
Canadian Institutes of Health Research / Instituts de recherche en santé du Canada
Institute of Infection and Immunity / Institut des maladies infectieuses et immunitaires

June 16th - 17th, 2008
Fairmont Royal York Hotel, Toronto

GenomeCanada

Written by: Judith Bray, PhD, Assistant Director, III
Creative Design and Cover Image by: David Hartell, Associate, Institute Strategic Initiatives, III

Canadian Institutes of Health Research
160 Elgin Street, Room 97
Address Locator 4809A
Ottawa, ON K1A 0W9

CIHR Institute of Infection and Immunity
Suite 214, Siebens-Drake Research Institute
1400 Western Road
London, ON N6G 2V4
Phone: 519.661.3228
Fax: 519.661.4226
iii@uwo.ca
www.cihr.gc.ca/iii.html

Cat. No.: MR21-132/2008E
ISBN: 978-1-100-10607-6

Canadian Microbiome Initiative

Workshop Report

CIHR IRSC
Canadian Institutes of Health Research | Instituts de recherche en santé du Canada
Institute of Infection and Immunity | Institut des maladies infectieuses et immunitaires

June 16th - 17th, 2008
Fairmont Royal York Hotel, Toronto

GenomeCanada

Table of Contents

Executive Summary 1

Background 4

Presentations 6

Partner Presentations 15

Breakout Session 1 15

Breakout Session 2 18

Conclusions and Next Steps 22

Workshop Evaluation 23

Appendix 1 - Agenda 24

Appendix 2 - Breakout Session Groups 26

Appendix 3 - Participant List 28

Executive Summary

Canadian Microbiome Initiative (CMI) Workshop Report

On June 16th and 17th, 2008, the Institute of Infection and Immunity (III) of the Canadian Institutes of Health Research (CIHR), in partnership with Genome Canada, hosted an invitational workshop to plan the future directions for the Canadian Microbiome Initiative (CMI). The CMI was created to provide an opportunity for Canadian researchers to contribute to international efforts to gain an understanding of the role of the human microbiome in health and disease.

Humans are more than the sum of their cells and in fact play host to literally trillions of microbes. Estimates put the count at more than ten times as many microbes as host cells, or in the region of 10^{14} per individual. Relatively little is known about these bacteria, viruses and protists but it is believed that they are intricately involved in maintaining equilibrium in the human body and perturbations in the microbiome have been associated with changes in health and the onset of disease. Following the sequencing of the human genome and the continuing rapid progress in technology, the means now exist to sequence whole communities of microbes isolated from their natural environments and explore the impact of these microbial communities on human health. The US National Institutes of Health (NIH) has already made a major financial investment to support the sequencing of the core human microbiome, and several other countries are involved in related projects of their own. Canada is ideally placed to take advantage of these ongoing initiatives to establish its own foothold in the field based on our unique Canadian strengths. In partnership with others, III is taking the lead in launching the CMI using seed money provided by CIHR and building of this base through partnership. Already III, in partnership with the CIHR Institute of Nutrition, Metabolism and Diabetes (INMD), has launched a Catalyst Grants Program to enable researchers to prepare for larger scale initiatives in the future.

The CMI workshop took place over a day and a half and involved more than 60 researchers and representatives from partner organizations. Researchers were drawn from both the genetic/bioinformatics and the immunology/infectious disease communities and the workshop provided ample networking opportunities in addition to an overview of current national and international research in the field. Participants were asked to combine their knowledge and expertise to provide recommendations to III and partners on the best way to move the CMI forward

and secure a place for Canada in the International Human Microbiome Consortium (IHMC).

There was general agreement among participants that the best course for Canada was to concentrate on 'what we do best', i.e. multidisciplinary team work that capitalizes on unique Canadian strengths. These strengths include our ethnically diverse population, our publicly funded health care system, and existing infrastructures such as our genome sequencing centres and developing cohort studies. Canada also has an excellent cadre of researchers working in microbiology, including environmental microbiology and infectious disease. It was felt that the key to success for CMI will reside in our ability to identify unique Canadian niche areas that will allow Canadian researchers to excel and establish an identity within the IHMC based on excellent science and innovative collaborative approaches. Proposed research areas where this might be achieved included:

While there are other areas of strength in Canada, participants stressed the importance of taking

Studies of the microbiome residing in the oral, gastrointestinal and urogenital tracts

This is an area in which Canada has significant expertise and research capacity, supported by an existing infrastructure which includes several cohort studies. Specific research areas in which strong Canadian expertise already exists were identified as inflammatory bowel diseases; food allergies and intolerance; development of the mucosal immune system and the effects of age and gender; the role of the microbiome in cancer; the developing microbiome from birth to old age and microbial transfer from mother to child; and the role of the microbiota in the progression of sexually transmitted diseases such as HIV/AIDS.

Studies of the microbiome associated with the nasopharyngeal and respiratory tract

One of the key priorities in this area would be to establish baselines for the normal flora in healthy individuals and standardize sampling techniques that could be applied to the entire respiratory tract, including the mouth and teeth. Through the development of technologies to enable the study of clonal dynamics over time it should be possible to follow fluctuations or adaptations in the microflora in the context of respiratory illness. Existing Canadian research capacity was identified in the areas of influenza, cystic fibrosis, pneumonia in the elderly, and phage.

The microbiome as it relates to the field of neuroimmunology

Neuroimmunology is a relatively new field in which there is growing Canadian interest and expertise. Current evidence suggests a possible association between alterations in the normal microbiome and psychiatric disorders such as depression, bipolar disorder and the autistic spectrum disorders. There is also mounting interest internationally in the field, particularly in Germany, the UK, Japan, Sweden and Ireland, suggesting the potential for international collaborations. This could be an area where Canadian researchers could establish an early foothold and, by bringing together existing small research groups, develop an innovative Canadian network.

Executive Summary

Studies of the human virome and the role of commensal viruses in health and disease

Although most current studies are focusing on bacteria, research on the human virome is likely to eventually become an important part of any microbiome initiative. It is also a field in which Canada has considerable research strength and capacity and could represent a true Canadian niche area. Current metagenomics technologies mean that it is feasible to assess the normal viral flora at sites such as blood, spinal fluid, urine, stool and lymph nodes and to study the role of phage as potential reservoirs of pathogenicity.

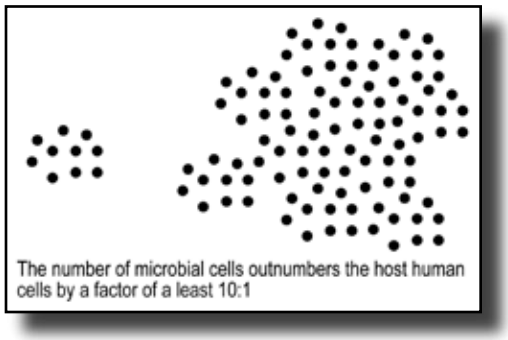
full advantage of existing infrastructures such as Canada's genome sequencing centres, relevant NCEs and the various cohorts now under development. The value of studies on the normal, healthy human microbiome was also stressed as was the need for communication and collaboration between researchers working on different body sites. Partnership will be a key component of a successful CMI both among different research communities and between organizations with complementary interests. In terms of future funding to support the growth of the CMI, a variety of programs from small pilot projects or proof of principle grants to larger multidisciplinary teams were proposed, depending on the relative strengths and capacity in the different research areas. For areas in need of capacity building, e.g. neuroimmunology, a consensus building workshop was suggested as an appropriate first step. It was recommended that preparation of a position paper, describing the value of large-scale multidisciplinary projects in moving the field forward, for consideration by Genome Canada may lead to additional federal funding for the CMI.

With respect to social, legal and ethical issues, it was recommended that the first step should be to raise awareness among that community of researchers on the importance of the human microbiome, it's impact on human health and disease, and the necessity to remain vigilant regarding questions of ownership, privacy and the potential ethical and social implications of manipulating the human microbiome.

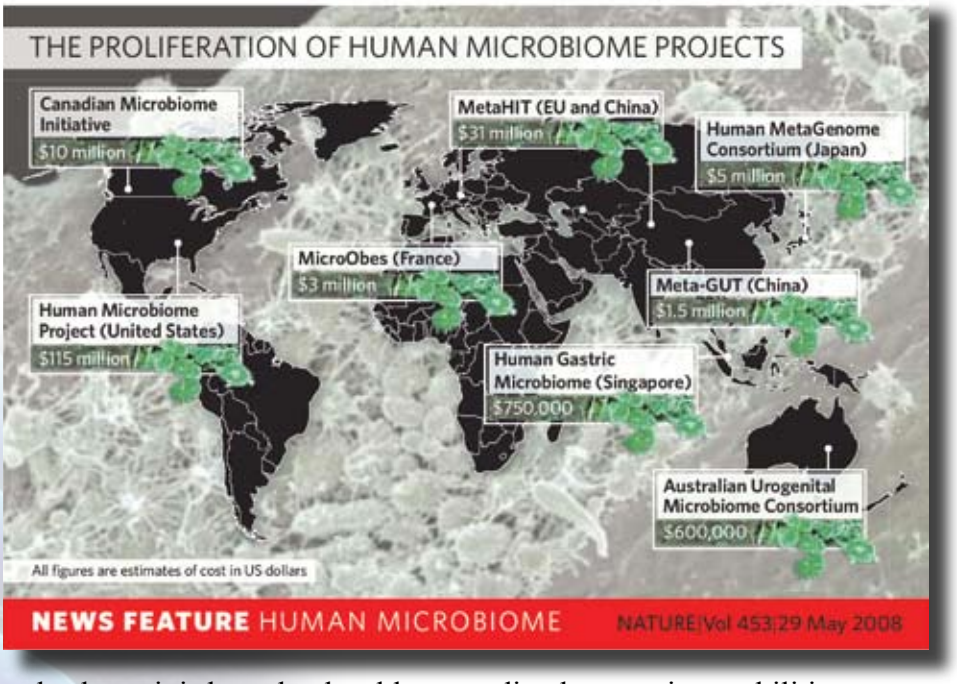
Based on the recommendations from the workshop, III and partners plan to take the necessary steps to develop a strong microbiome research community in Canada. III will play an important role within the IHMC and will work with partners over the coming months to develop and launch large targeted research initiatives. These initiatives will serve to develop capacity and create new knowledge about the human microbiome and its role in human health.

Background

The human body plays host to trillions of microbes, including bacteria, viruses and protists. These microbes constitute the "Human Microbiome" that resides both on the surface and deep within numerous sites in our bodies. It is estimated that the number of microbial cells outnumbers host cells by a factor of at least 10:1 and that they encode approximately 100-fold more genetic information than the human genome. The composition of an individual's microbiota is controlled by a combination of genes, age, diet, lifestyle, environmental factors and geography. The effect that these microbes have on human health and disease is in most cases unclear, although associations have been made between colonizing microbes and a variety of chronic diseases such as cancer, gastrointestinal disease, diabetes, obesity and cardiovascular disease. Our innate microbial communities undoubtedly also play an important role in normal human development, physiology, immunity and nutrition. The lack of hard data is a consequence not just of the sheer numbers of microbial species, but also the difficulty of applying standard microbiological techniques, such as cell culturing, to the study of individual species and their interactions with each other and their hosts.


The number of microbial cells outnumbers the host human cells by a factor of a least 10:1

Since the human genome project, genome sequencing techniques and bioinformatic capabilities have continued to rapidly advance to the point where it is now possible to examine whole communities of microbes extracted from their natural environments. Metagenomics studies are increasingly feasible, due to the capacity to process billions of DNA base pairs in a few days, generating gigabytes of data, in turn supported by the immense power of current computational infrastructure and software. Initial plans to study the human microbiome centre on generating reference libraries of the genomes of a few hundred microbes that will represent a common, core microbiome. Using this reference database, it is hoped to be able to predict the genetic capabilities of unknown species on the basis of similarities with known genes. Much of the initial sequencing



work is being undertaken by the National Institutes of Health (NIH) as part of its Human Microbiome Project (HMP), but the vast amounts of data required calls for a coordinated international approach in which common techniques are used to collect samples, extract DNA and annotate data. Hence the recent creation of the International Human Microbiome Consortium (IHMC), which hopes to coordinate the large number of microbiome initiatives springing up around the world in places such as the EU, China, Japan, Singapore, Australia and Canada. The largest project in terms of financial investment is the US HMP ($115 million), followed by the Metagenomics of the Human Intestinal Tract (MetaHIT) project in the EU and China ($31 million) and then the proposed $10 million investment by Canada, led by the Canadian Institutes of Health Research (CIHR). Approaches differ with the US HMP focusing initially on genomic sequencing and creation of a reference database (600 genomes) along with development of the new technological and bioinformatics tools that will be necessary. In contrast, the EU MetaHIT program, although planning initial sequencing of 100 reference genomes, will focus from the outset on the role of the gut microbiota in obesity and inflammatory bowel disease. Canada's entry into the IHMP has been led by Dr Bhagi Singh, Scientific Director of CIHR's Institute of Infection and Immunity (III). III and Genome Canada jointly represent Canada on the IHMC steering committee.

On behalf of CIHR, III is facilitating the development of a conceptual framework for a Canadian microbiome strategy and engaging Canadian researchers in establishing research strategies and priorities related to the HMP. In September 2007, III hosted a consultation meeting in Vancouver to discuss the formation of the Canadian Microbiome Initiative (CMI). The primary outcome from this meeting was a recommendation to build on Canada's unique strengths, and to focus on high throughput experimental exploration of the role of the microbiome in targeted disease states and aspects of health.

In follow up to this meeting, CIHR-III arranged a teleconference of potential partners in March 2008, at which it was decided that CIHR-III and Genome Canada would organise and co-host a Canadian Human Microbiome Workshop. A working group was established to determine the scope, logistics and agenda for the workshop (see Appendices 1 and 2), which took place on June 16th and 17th in Toronto.

Working Group Members

Jane Aubin, CIHR-IMHA, U of T	Karen Kennedy, Genome Canada
Judith Bray, CIHR-III	Allison McGeer, U of T
Ford Doolittle, Dalhousie University	Bhagi Singh, CIHR-III, UWO
Brett Finlay, UBC	Mike Surette, U of Calgary
David Hartell, CIHR-III	George Tolomiczenko, CCFC

The one and a half day workshop engaged over 60 researchers and representatives of potential partner organizations in a series of "stage-setting" presentations and informal breakout discussions leading to a series of recommendations as to how III and partners could best move forward in developing the CMI.

DAY 1

Day one was devoted to a number of overview presentations from invited experts in the field, in order to ensure that participants were "on the same page" for the interactive discussions on the second day.

Presentations

What follows is a brief description of the highlights and "take home messages" from each of the nine presentations. Contact information for each of the presenters is listed in Appendix 3, should further, more detailed information be required.

The Canadian Microbiome Initiative (CMI)

Dr Bhagi Singh, CIHR Institute of Infection and Immunity

The Canadian Microbiome Initiative (CMI) falls under "Emerging Infections and Microbial Resistance", one of the five strategic priority areas identified by III in its 2007-2012 Strategic Plan. Studies of the human microbiome are gaining momentum, with related articles appearing in recent issues of both Nature and Science. The NIH-led HMP plans to sequence and analyse the genomes of the human microbiome from selected body sites to determine whether there is a core set of microbiota shared by all humans, and to assess the role of the human microflora in health and disease. To support this aim, new technological and bioinformatic tools will be developed and ethical, legal and social issues will be explored. The CMI will be developed to align with the HMP by taking advantage of unique Canadian strengths (e.g. collaborative research culture, established genome centres, research strength in "omics" and infectious diseases, publicly supported health care system) and mobilizing funding for microbiome research in Canada. CIHR-III has already secured significant funds in support of CMI and additional funds will become available through partnerships, some of which have already been identified. In addition, a funding opportunity for one-year catalyst grants was launched by III with the CIHR Institute of Nutrition, Metabolism and Diabetes (INMD) in June 2008 to provide researchers an opportunity to prepare for anticipated larger funding opportunities.

Genome Canada Perspective

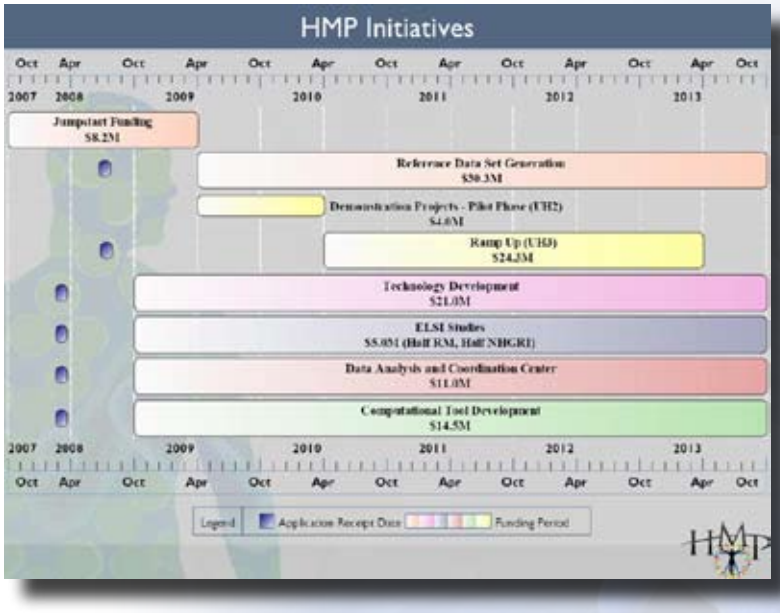
Karen Kennedy, Genome Canada

Genome Canada is a private, not-for-profit corporation that, since 2000, has received $840 million in funding from the Federal Government. Through its six Genome centres (BC, Alberta, Prairie, Ontario, Quebec and Atlantic), Genome Canada funds over 2,000 scientists and technicians engaged in managing large-scale genomics projects and their supporting science and technology platforms. To date, Genome Canada has held six competitions and funded more than 100 large scale projects (average $10 million over 3-4 years), for which up to half the costs can come from Genome Canada with the remainder coming from matching funds. In addition, three international consortia worth in excess of $50 million over three years have been funded, with up to 25% of the funds originating from Genome Canada. Priority research areas are identified through the development of position papers. Successful papers lead to the development of a funding request submitted to the Federal Government for additional targeted funds. Genome Canada is particularly interested in exploring what the important research questions in this area are, how large scale collaboration in genomics and proteomics will be crucial to rapidly advancing the field, and what opportunities there are for international partnerships through the IHMC. Genome Canada is co-hosting this workshop with III in order to identify Canadian expertise, priority research areas and the capacity for international partnerships. Genome Canada does not currently have funding to support an initiative in this area: the strategic case would need to be made in order to raise funding from the Federal Government.

NIH Roadmap 1.5 – Human Microbiome Project

Jane Peterson, NHGRI, NIH, USA

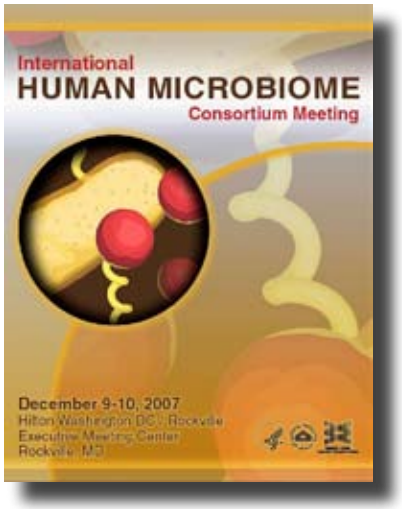
According to its mission statement, "The NIH HMP is a feasibility study designed to determine the value of microbial metagenomics to biomedical research by characterizing the microbes that inhabit the human body and examining whether changes in the microbiome can be related to health and disease." The five-year, $115 million project which has been launched will be funded in three stages - September 2007, September 2008, March 2009. It is recognised that the NHGRI-led HMP is far from being the only player in the field, as in addition to international efforts, several other NIH Institutes are involved in related projects. The hope is that the results of the early pilot projects will encourage increased investment into the HMP and empower researchers to incorporate metagenomic studies into their



research. The HMP Jumpstart program (launched in 2007) will support the genomic sequencing of 200 human-associated microbes and sample approximately 250 individuals for sequencing of standard marker genes like those encoding 16S ribosomal RNA (16SrRNA). This program has already set operating standards, agreed to an initial strain list and explored mechanisms for data sharing. Volunteers are recruited by advertisement and are sampled from multiple sites immediately and one year later. Initially the primary focus will be on bacteria but viruses are likely to be included by some groups in the near future. Subsequent initiatives include the following:

- **Initiative 1: Data Resource Generation** – sequencing of 400 strains of prokaryotic microbes from different body regions; recruitment of donors; collection of samples; metagenomic sequence analysis;
- **Initiative 2: Demonstration Projects** – relationship between changes in the human microbiome and health or disease onset;
- **Initiative 3: Technology Development** – development of improved culturing techniques; individual microbe sequencing;
- **Initiative 4: Ethical, Legal, and Social Implications Research** – clinical and health; forensics; uses of new technologies; ownership of microbiome;
- **Initiative 5: Data Analysis and Coordinating Centre** – tracking, storing and distributing data; data retrieval tools; coordination of analyses and metadata standards; creation of a portal for international activities; and
- **Initiative 6: Computational Tool Development** – new tool development; next generation sequencing platforms; large, complex sequence data; functional data and metadata.

In addition, a resource repository will be established to make materials and reagents available to researchers at a reasonable cost and a central data repository will be provided by NCBI for sequencing and clinical data. It is hoped that the formation of the IHMC will serve to coordinate, standardize and promote the production of a robust, freely available HMP data source. IHMC is open to any qualified group that agrees to IHMC principles and is guided by an international Steering Committee, supported by ad hoc working groups as required. The formalization of IHMC is scheduled to take place in October 2008 in Heidelberg.



Bugs "R" Us

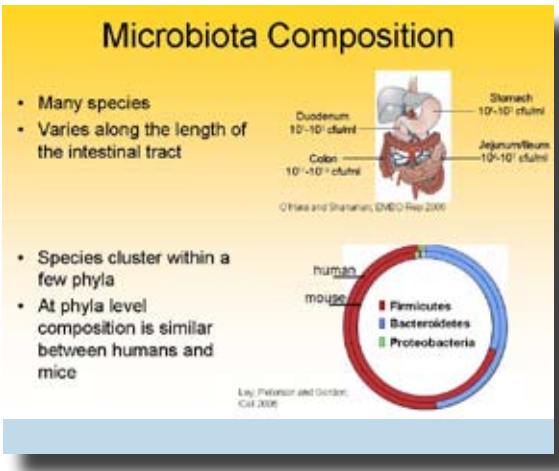
Brett Finlay, Michael Smith Laboratories, UBC

The human microbiome resides primarily on the surfaces of the body that are exposed to the external environment such as eyes, respiratory/nasopharyngeal tract, skin, gastrointestinal tract (especially large intestine) and the urinary genital system. There is a vast variability in flora and concentrations between the various sites and even in different locations within the same site. Despite the large species representation (approximately 500), most belong to just three out of several dozen known bacterial phyla (Firmicutes, Bacteroidetes, Proteobacteria) and at the phyla level the composition is similar between humans and mice. In the human GI tract, more than 90% of bacteria fall into just two phyla and appear to provide a protective role with structural functions in immune systems and epithelium development, and metabolic functions in metabolism and vitamin synthesis. Despite the large numbers of microbiota and their protective value they do not appear to be essential to life, or at least not life in a sterile environment, as demonstrated by animal models and rare cases of humans reared in germ-free conditions (e.g "bubble boy", David Vetter who lived to be 12 years old).

"All the people living in our United Netherlands are not as many as the living animals that I carry in my mouth this very day"

Anthoni van Leeuwenhoek, 1683

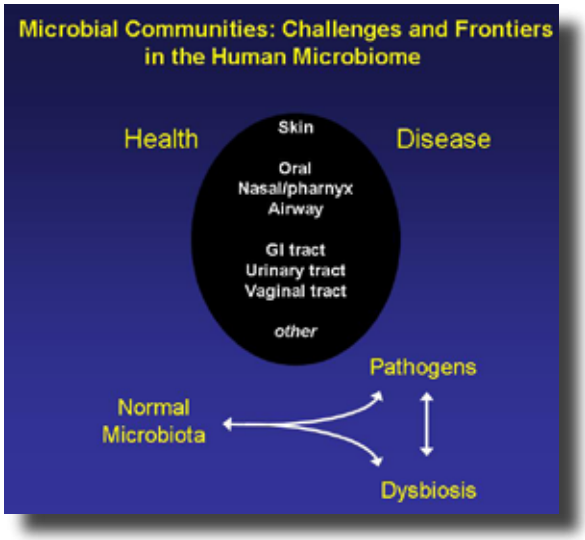
The impact of the human microbiota on health and disease has long been debated and increasing evidence, although often circumstantial, suggests a direct link. One example is mounting evidence for a possible microbial component in obesity. Animal studies offer support for this theory, where the transfer of microbiota from fat animals into thin ones makes the latter group gain weight. Another well documented area for microbial involvement is inflammatory bowel disease or ulcerative colitis, where a significant difference has been shown between the microbial flora of patients and control subjects. Similarly the microbiota may be involved in atopic diseases such as asthma and allergy. It has been suggested that the increase in both diseases in the western world (but not the developing world) could be due to "too clean a lifestyle" with reduced exposure to microbes early in life. There are several studies which suggest that an individual's microflora, once developed, remains constant unless perturbed by some external force such as invasion by a pathogen as for example, in diarrheal disease. Animal studies show that while an invading pathogen does affect the host microbiota, not all phyla are affected to the same degree and the pathogen does not overrun the entire host population. Once the pathogen has been eliminated the microflora soon returns to normal. Similarly, in humans the microbiota changes as a result of antibiotic treatment but soon returns to normal once the antibiotic is withdrawn. This could have a major impact on diseases such as infections caused by *Clostridium difficile* (*C. difficile*).



Microbial Communities: Challenges and Frontiers in the Human Microbiome

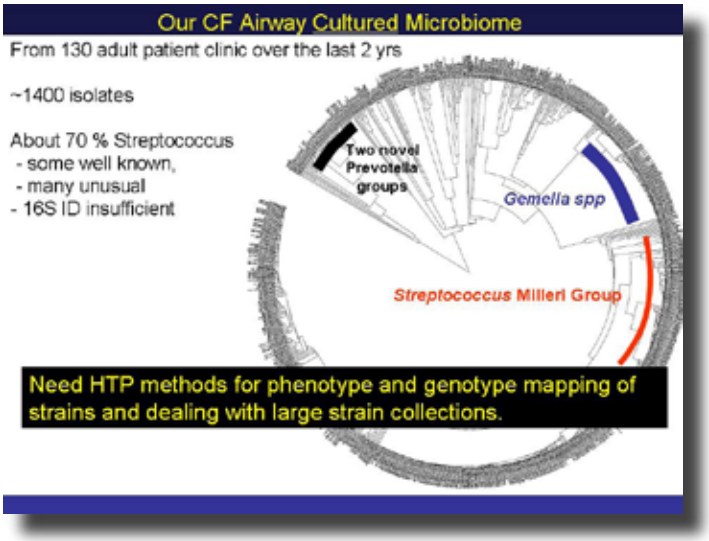
Mike Surette, University of Calgary

Although most current microbiome studies are focused on bacteria it is important to remember that the human microbiota also includes fungi, protists and viruses, all of which have an impact on health and disease. The polymicrobial nature of the human microbiome and the interplay of host genetics, environment and chance are important factors in understanding the relationship between disease and health. As the microbiota first becomes established, this community drives the development of the immune system which in turn impacts on the development of an individual's unique microbiota. Once established, an individual's microbiota appears to be relatively stable, although it is likely that there are constant changes and adaptations at a finer resolution.



There is often a close relationship between commensal flora and pathogens and many infectious diseases are a result of complex interactions between the pathogen, the commensal microbiota, the host, and the environment. In polymicrobial infections the distinction between pathogen and normal flora is often blurred and disease may result from a perturbation in the natural flora as much as from the pathogen itself. There are many examples of microbes that are part of the asymptomatic normal flora in some individuals but cause disease in others or even of fluctuations over time in the same individual. For this reason, research in human systems, as opposed to animal models, is very important if we are to understand the complex interactions and fluctuations in microbial communities over time.

Microbes frequently behave as coordinated populations of cells rather than as individual organisms and interactions among bacteria can be through physical and chemical mechanisms. Community dynamics and stability depend to a large extent on small molecule interactions which range from neutral or cooperative to competitive (active and passive). Genetic profiling may not necessarily reflect the behaviour of whole communities and gives little insight into the dynamic interactions that take place in both health and disease. There are many molecular and sequencing techniques, and high throughput methods available for phenotype and genotype mapping of strains that can be cultured and for handling large strain collections, e.g. cystic fibrosis associated microbiome. However, methods and analysis tools for phenotype profiling

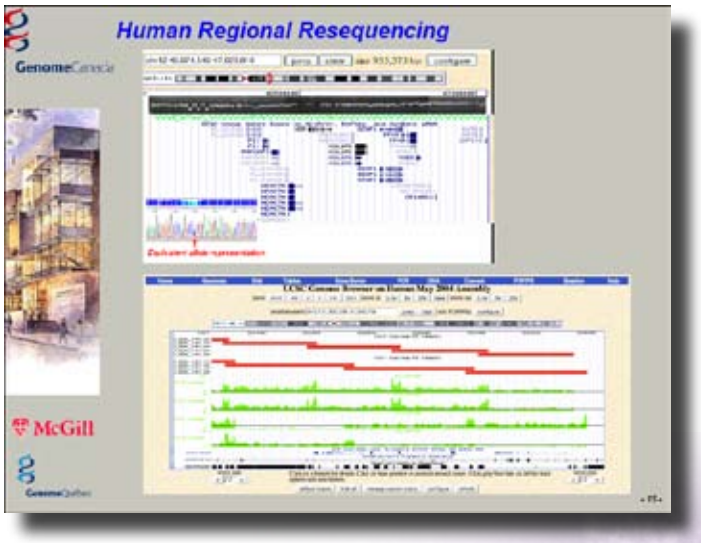


of whole microbial communities (such as transcriptomics, metabolomics) are needed to understand the underlying biology of the human microbiome. In addition, improved methods are required for studying currently unculturable organisms and new approaches to "culturing the uncultured" are required. Sequencing data alone is not enough to examine the dynamics and strain variation of whole communities over time. More quantitative microbiological data that can be correlated with patient data for large data sets is also needed to explore the patterns of interaction within and between microbial communities and to study normal baseline microbiota.

Next Generation Sequencing and Metagenomics

Ken Dewar, McGill University and Genome Quebec

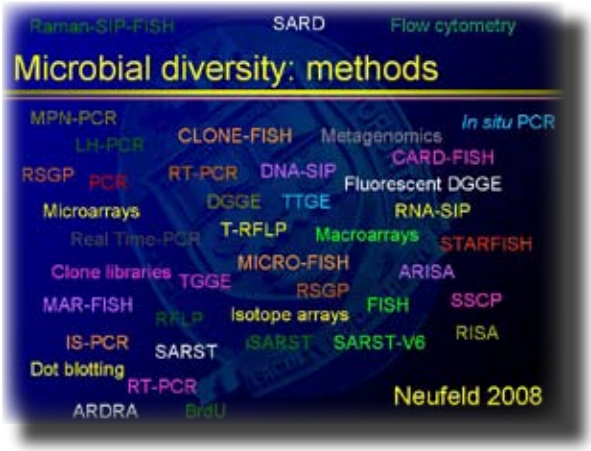
Canada already has several genome sequencing centres across the country that are equipped with state of the art equipment (e.g. Illumina/Solexa, Roche/454 GS-FLX, ABI SOLiD,) and highly trained staff. The new systems are relatively affordable but remain costly to implant into labs and so infrastructure still tends to be consolidated in the large platforms supported by Genome Canada and the Canadian Foundation for Innovation. The production of vast amounts of sequencing data in relatively short time frames has driven the requirement for high performance computing technologies and storage facilities. These new DNA sequencing systems have caused a revolution in high throughput sequencing, with vastly increased throughput, and for some technologies read length is now approaching gene length. While the technologies are constantly evolving, the latest systems can already generate 3 Gigabytes of sequence data (equivalent to the size of the human genome) for less than $10,000 in approximately one week. Bacterial genome sequencing can now move from receipt of DNA to delivery of assembly in just four days. These new technologies are ideal for studying the microbiome, especially the rarer strains and strain variations. Researchers using state of the art equipment at the Genome Quebec Innovation Centre in Montreal have recently sequenced 10 genomes from epidemic and non-epidemic *C. difficile* isolates revealing potential diagnostic sequences and vaccine targets, and providing insight into disease pathogenesis. The development of new and ever faster technologies has enabled sophisticated studies of gene expression and regulation (e.g. work by Ken Hastings at McGill), metagenomic sequencing, proteomics, and studies on biodiversity. Unfortunately the relatively easy and rapid generation of these vast amounts of data can become impeded by issues around access, ownership, and material transfer and national and international sharing of strains and isolates.



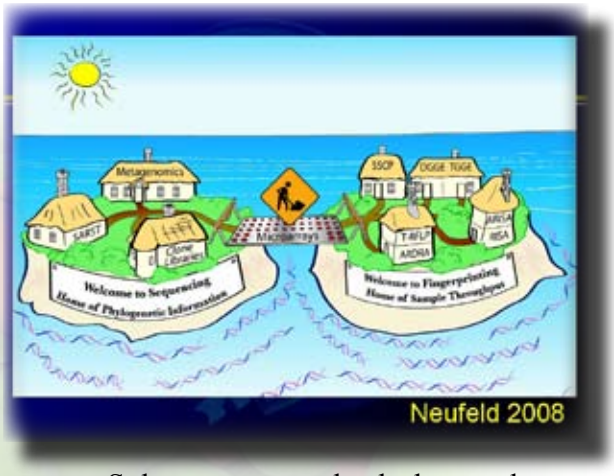
The Oral Microbiome: status and future directions

Dennis Cvitkovitch, Dental Research Institute, University of Toronto

Oral pathogens are opportunistic in nature and under normal conditions do not cause health problems. Dental plaque is an excellent example of microbial biofilm formation – colonies of bacteria that grow on a surface in a non-sterile, wet environment. It is estimated that 65% of human bacterial infections involve biofilms and 95% of systemic infections have an oral origin. The plaque environment is dynamic and extremely diverse with more than 800 species already identified. Dental disease, such as cavities or periodontal disease, occurs when the normal microbial balance is disturbed as a result of changes in environmental conditions, e.g. excess sugar, drop in pH. Studies of the oral microbiome, therefore, represent an excellent model for studies on biofilm ecology and microbial diversity. Josh Neufeld at the University of Waterloo has played a major role in establishing collaborations to address diversity and function in relation to the environment and his lab is involved in developing new molecular methods to identify and characterise low abundance microbial species.



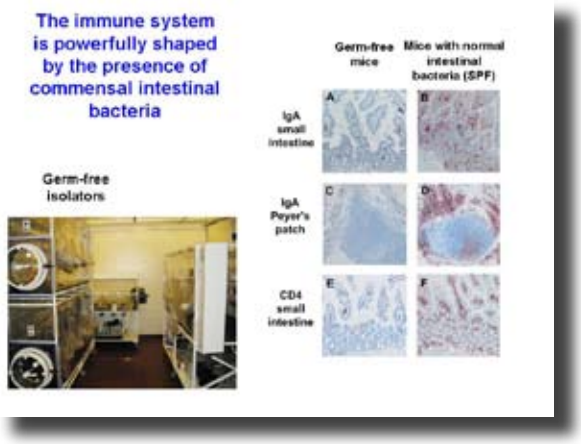
With the advent of new DNA sequencing technologies and the emerging field of metagenomics it is now possible to study whole communities of microbes and examine inter-species and microbe-host interactions. The human microbiome project is very timely for studying the oral microbiome and construction of a human oral microbiome database with an anticipated 600 prokayote species is already underway. There are now many methods available for the study of microbial diversity, but one of the challenges remains sampling size. To rigorously assess the association of specific species or phylotypes with oral health, it will be necessary to analyze extremely large numbers of clinical samples to detect all the microbiota present, especially those in low abundance. Of the currently available techniques, serial analysis of ribosomal sequence tags (SARST), which targets the most variable region of 16S rRNA, appears to be the best for profiling complex microbial communities, generating as many as 20 sequences per Sanger sequencing reaction. From the available sequencing equipment, the Illumina Solexa appears to be the best and can easily be adapted to existing SARST protocols, providing near complete surveys of microbial diversity rapidly and for an affordable cost. Disadvantages include short sequencing, which may preclude some analyses and the rapid generation of enormous amounts of data, requiring advanced computational and bioinformatics data handling capabilities.



Dynamic mutualism between the host commensal intestinal flora and the mucosal immune system

Andrew Macpherson, McMaster University

The human lower intestine is populated by an enormous number of microbes - in the range of 1,000 billion bacteria/ml of contents or as many as 10^{14} per individual. These microbes are separated from the rest of the body by only a thin layer of cells and mucous lining the intestinal tract. As long as the intestinal microbial population does not penetrate the intestinal barrier, they coexist in relative harmony and in fact play a valuable role in digestion and processing of essential nutrients. It is believed that our commensal intestinal population is kept in place, in part, by the extremely active mucosal immune system present in the intestinal lining. If these protective systems fail however and bacteria penetrate the intestinal lining, severe intestinal damage and serious illness can result, e.g. inflammatory bowel disease, Crohn's disease, ulcerative colitis. Damage is often long lasting and, for example, of those suffering acute gastroenteritis as a result of the Walkerton outbreak, 30% suffered post infective irritable bowel syndrome as a result of perturbations in the bacterial flora and increased intestinal permeability.

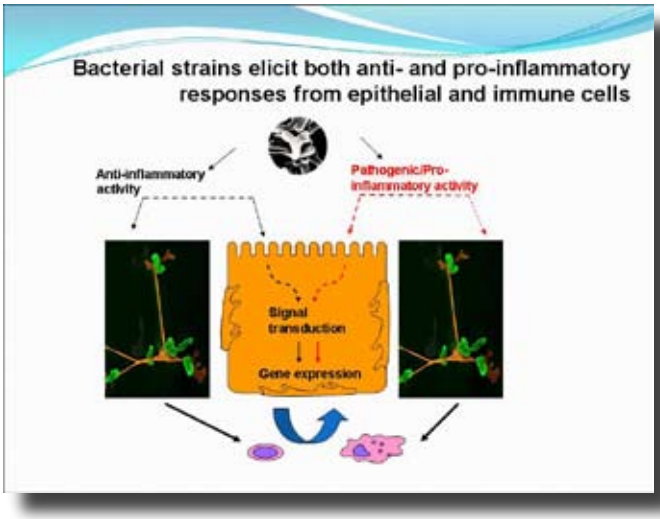


In both animal and human neonates, the intestine is populated almost immediately after birth and this natural microbiota has a significant effect on the development and maturation of the host immune system. The Farncombe Gnotobiotic Facility at McMaster University has provided a resource for the study of germ free or gnobiotic animals and the interactions between the immune system and the commensal flora in adult and neonatal mice. The ability to specifically control the species populating the flora in modified, gnotobiotic mice has provided valuable information on how the immune system is shaped by the presence of commensal intestinal bacteria. For example it has been shown that dendritic cells sample commensal microbes and induce B cell responses and the development of IgA plasma cells. The produced antibodies bind to the bacteria preventing penetration across the intestinal wall. There is also evidence that the intestinal microbiota can influence gut-brain interactions resulting in altered pain perception and behavioural changes. In turn the immune system is adapted by the presence of microbes. Recent work using transposon libraries and transposon insertions has enabled dissection of the colonization by, and function of, the microbiota in different systems in wild type and immune deficient mice.

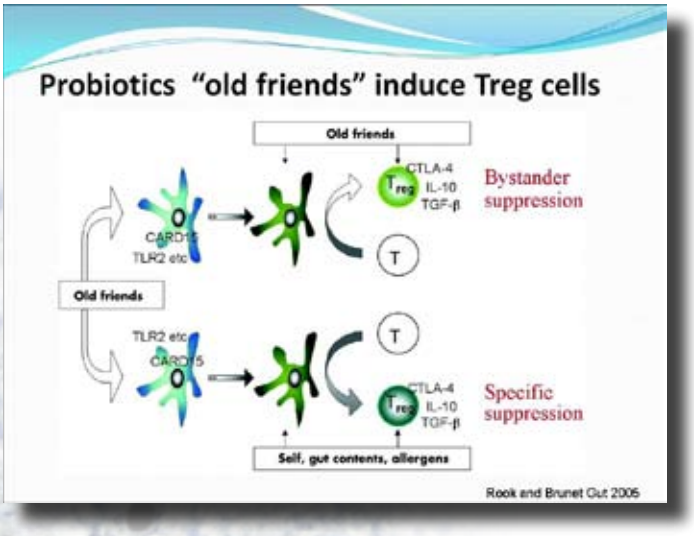
Probiotics: What do we know and what do we need to know?

Karen Madsen, University of Alberta

Probiotics are monocultures or mixed cultures of live, non-pathogenic micro-organisms thought to benefit the health of the host. Common probiotic strains include *Lactobacillus, Bifidobacteria* and *Streptococcus*. Probiotics have been used clinically in the treatment of gastrointestinal disorders such as: inflammatory bowel disease; pancreatitis; diarrhea; constipation; necrotizing enterocolitis; systemic immune disorders such as asthma and atopic dermatitis; and in other areas such as weight loss and halitosis. There is some evidence of the beneficial effects of probiotics from human, animal, and in vitro studies.



Oral probiotics interact with immune cells, epithelial cells and the microflora along the entire intestinal tract and can elicit both anti- and pro-inflammatory responses. Effect is host, dose and strain dependant and can include a range of responses from no response to both suppression or heightening of an immune response. Probiotics may also demonstrate antimicrobial activity. Probiotics can enhance the gut barrier function at the epithelial cell tight junction level and regulation of mucus production. Probiotics do not colonize the host and usually disappear between three and thirty days after withdrawal, although they may linger longer if given to a neonate. Probiotics exert several immunomodulatory effects including induction of regulatory T cells.



Future research should focus on the ideal therapeutic indication for administration of probiotics; which bacterial species or strains to use and at what concentration; whether to use single or mixed strains; and the necessity for live bacteria as opposed to bacterial products. The key to success is likely to lie in the ability to match the correct probiotic strain to the appropriate clinical condition. Currently we are in a "consumer beware" situation with respect to over the counter probiotic preparations and foods.

DAY 2

Day 2 began with four brief and informal presentations from representatives of four of the partner organizations present at the workshop, followed by two breakout sessions and a final summary discussion among all participants.

Partner Presentations

Each presenter said a few words about the nature of their organization and the reason for their interest in the Canadian Microbiome Initiative. All expressed an interest in working with III in developing potential partnerships as we move ahead. Further information about all the organizations can be found at the web sites shown below.

Klaus Fiebig

Ontario Genomics Institute –http://www.ontariogenomics.ca/main/home.asp

Thomas Tompkins

Lallemand – Institut Rosell - http://www.institut-rosell.com

George Tolomiczenko

Crohn's and Colitis Foundation of Canada –- http://www.ccfc.ca/English/index.html

Dean Befus

AllerGen NCE - http://www.allergen-nce.ca/

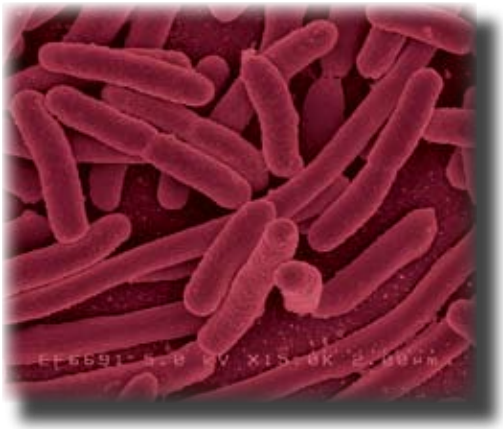
Breakout Session 1

For Breakout Session 1, participants were assigned to one of four groups based on expertise in order to provide a range of different perspectives in each group, from sequencing/bioinformatics to biology of the microbiome (see appendix 2). Each group was provided with three questions, suggested guidelines for discussion and a report back template. The highlights of the discussions and final conclusions are summarised below.

Question 1

The systems, technologies and laboratories are now available to rapidly identify and sequence microbes. How can Canada best take advantage of existing resources and infrastructure to advance our knowledge and understanding of the role of microbiota in health and disease?

- Canadian strengths include the various cohorts (cancer, IBD, pediatric) and biobanks that exist across the country and which provide access to both patient and healthy samples; our integrated, publicly funded health care system; strong clinical networks; a wealth of "omics" expertise; an existing culture of collaboration; germ free facilities (e.g. McMaster); research strengths in the area of probiotics; our multi-cultural society that provides access to populations of broad ethnic diversity; and several relevant NCEs and NGOs.



- As sophisticated sequencing technologies become more accessible and affordable bottlenecks are occurring at the data analysis and experimental design stage. Increased support in bioinformatics/informatics/statistics/ epidemiology/mathematical ecology is required in order to handle the vast amounts of data generated by new technologies. This will require extensive training and capacity building in these areas if we are to be able to take full advantage of the information being generated both in Canada and internationally.

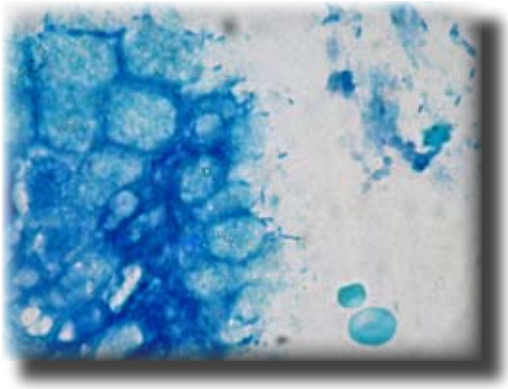
- Canada can best take advantage of existing resources and infrastructures by selecting areas that represent a true Canadian niche; building strong collaborations based on our available expertise; and supporting multidisciplinary teams through a variety of funding mechanisms from small start-up or proof of principle grants to large multi-year team/consortia grants. Partnerships between organizations will also be a key factor in obtaining a sustainable Canadian foothold in the field.

Question 2

What are the important research questions in human microbiome research where large scale collaborations in genomics and proteomics will be crucial to rapidly advancing the field?

- Our strong research base in microbiology, including environmental microbiology, makes the biology of the microbiome and 'culturing the unculturable' an area where Canadian researchers could excel. It will be important to focus on the diversity within the microbiome, fluctuations over time within individuals and across populations, and changes in the microbiome in health and disease. It will be particularly important to establish baseline measures in healthy populations rather than focusing exclusively on disease, although the relationship between pathogens and the normal healthy flora is an important area of study.

- It will be important to focus on areas of Canadian expertise and research capacity e.g. oral microbiome, GI tract, vaginal flora, respiratory tract (cystic fibrosis), mucosal immunity. Studies on the vaginal microbiome may represent a niche area as there are currently fewer studies in this area and it is a less complicated environment than the GI tract. There are also opportunities related to pregnancy, childbirth, neonatal development over time, and the effects of breast feeding. Collaboration and the support of multidisciplinary teams able to take a systems biology approach will an important element of success in moving forward the Canadian agenda.



- Viral metagenomics for the discovery of novel pathogens or triggers of disease is an area currently understudied when compared to bacterial metagenomics. However it is an area where Canada has considerable research strength and may therefore represent a potential niche area that provides an opportunity for international leadership.

- The involvement of environmental agents and the role of the normal microflora in complex diseases, such as cancer and cardiovascular disease, and also in outbreaks e.g. SARS, *C. difficile*, are also areas where Canada could have an impact

- Studying the impact of nutrition on the microbiome in health and disease is another area of potential opportunity for Canadian researchers. There are several food companies and an NCE (AFMNet in Guelph) that might be potential partners in this area as well as several agricultural centres.

- Canada's ethnic diversity provides the opportunity to study the microbiome as individuals change their geographical location, or to compare the microflora of recent immigrants with those remaining in the homeland. Canada's unique Aboriginal population also creates opportunities for original studies.

Question 3

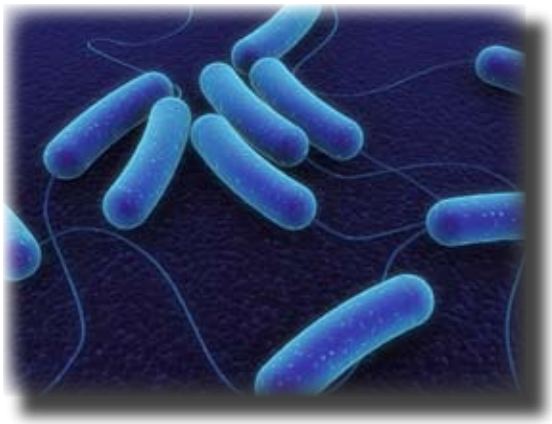
Are there any major ethical, legal, social and/or regulatory impediments to moving forward, and if so, what are they and how could they be addressed?

- Although many of the potential issues are already being addressed in other fields, there may be regulatory problems down the road with the IP of the microbiome. The microbiome is unique for each individual and identification of new microbes or new links between microbes and disease may raise reporting and confidentiality concerns.

- There may also be problems if we start manipulating the microbiome, for example, with probiotics. Regulatory guidelines are starting to arise in the EU, but as yet most probiotic preparations are unregulated. It will be important to know what effect these drugs have on the normal microflora and their capacity to do harm by disrupting normal communities.
- Biobanking is still a vulnerable area that raises the question of who owns the samples.
- Sharing data across provincial borders remains a challenge in Canada.

Breakout Session 2

For the second Breakout Session, participants were grouped roughly according to area of expertise, but were allowed to re-position themselves if they felt their primary topic of interest aligned better with a different group. Participants were encouraged to form their own groups if they felt that their field was underrepresented at the workshop, but that their topic was an important one (see appendix 2). Each group was asked to consider what the specific research questions in their area would be: what kind of approaches would best address these questions; and what the next steps in developing the Canadian Microbiome Initiative might be from the perspective of CIHR, Genome Canada and other interested parties.

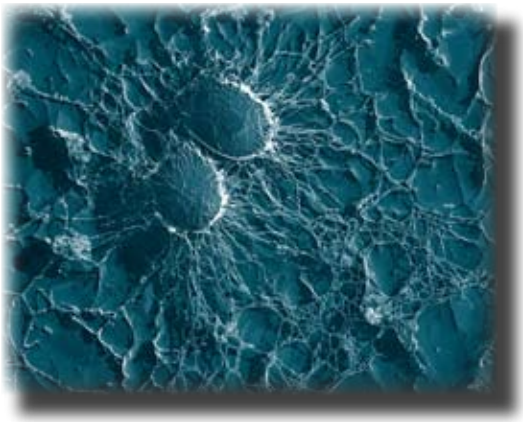


Gastrointestinal, Oral and Urogenital Group

This group focused on the considerable research strengths and available infrastructures already available in Canada and how they could best be used to support the CMI. Many potential research questions and topics were identified, including:

- inflammatory bowel diseases (IBD);
- food allergy and intolerance;
- development of the mucosal immune system and the effects of age and gender;
- the role of the microbiome in cancer;
- the developing microbiome from birth to old age and microbial transfer from mother to child; and
- the role of the microbiota in the progression of sexually transmitted diseases such as HIV/AIDS.

The group stressed the need for communication and collaboration between researchers working on different body sites as many are linked, e.g. the mouth is part of the GI tract, but the flora are very different. It is also likely that the gut flora and perturbations in this flora may have impacts at more distant sites e.g. gut-brain interphase, development of cancer, arthritis and diabetes. The group supported alignment with existing platforms such as the Gene, Environment and Microbe (GEM) project, a multi-disciplinary multi-centered prospective study of healthy subjects at high risk for developing Crohn's disease. In this cohort study, researchers plan to recruit 5,000 healthy subjects (between the ages of 6 and 35 years), identified as being at high-risk of developing IBD. Once recruited, biographical and environmental information of subjects will be collected, baseline intestinal permeability will be measured, and stool and blood samples will be collected and stored.



Similarly the CHILD study, co-funded by CIHR and the AllerGen NCE, will follow 5,000 Canadian children from pregnancy through early childhood and investigate the roles of indoor and outdoor environmental exposure, infections, nutrition and genetics in the development of asthma and allergies. Several Canadian provinces are also embarking, or have already started, on a national colorectal cancer screening campaign which will involve, in most cases, the repeat collection of fecal samples. There is some evidence to suggest a link between normal gut flora and both stomach and colorectal cancer, so this study could also provide a valuable resource for microbiome studies.

The group also pointed to the need for well aligned animal and human studies in which information gained in experimental model systems can be rapidly evaluated in the clinical setting. Caution was encouraged when considering potential commercial outcomes such as probiotics, dietary interventions, diagnostics and biomarkers as the supporting science needs to be very sound.

In terms of next steps the group felt that small targeted, multi-disciplinary teams would allow the greatest flexibility and that this should be supported by training programs, and symposium/workshop grants. Partnerships were seen as a vital component in building capacity and enabling alignment with ongoing projects and an emphasis was placed on the need for research on normal flora in healthy individuals rather than being solely disease-based.

Neuroimmunology

This group identified neuroimmunology as an emerging research field. Observational evidence exists for a two-way linkage between the microbiome and its products (e.g. neurotransmitters,

fatty acids) and both the immune and nervous systems. There are suggestions that changes in the normal microbiome can result in changes in behaviour and vice-versa and a relationship has been suggested between the microflora and major psychiatric disorders such as depression, bipolar disorder and autistic spectrum disorders. In animal systems it has been shown that perturbing the microbiota generates alterations in behaviour through chemical changes in the brain. Stress has also been shown to affect the microbiota in experimental systems. In humans, it has been shown that the gut profiles are abnormal in women with depression and that probiotics may have a therapeutic effect. It is likely that early colonization plays an important role in the maturation and development of both immune and neurological responses. As the nervous system is central to the human body it could be considered to link all the respective body parts and so studies could span a wide range of areas. There is also considerable interest in this field internationally in Germany, the UK, Japan, Sweden and Ireland, raising the possibility of international collaborations.

The group recommended that as the field is in its infancy, the first step should be to hold a workshop to bring together the Canadian and international expertise. It was suggested that III and CIHR's Institute of Neurosciences, Mental Health and Addiction (INMHA) could potentially organize such a meeting. One of the aims would be to bring scientific credibility to the area and build capacity for future research projects. It was felt that the community would initially benefit the most from Proof of Principle or individual operating grants, with small team grants perhaps being an option in the longer term.

Respiratory System

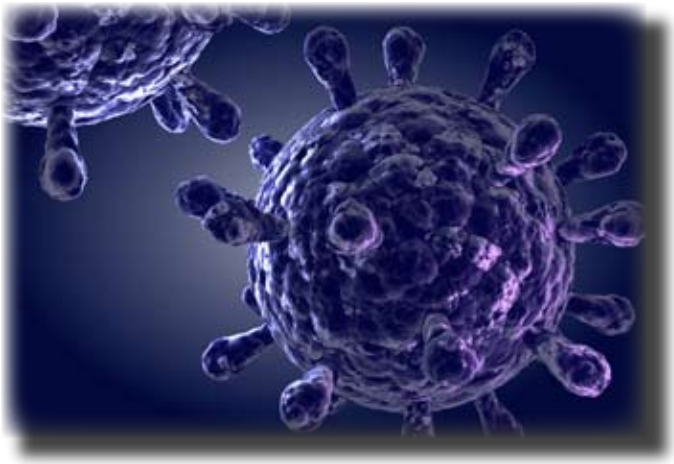
This group identified the following research areas as being of high priority:

- Establishing sampling (e.g. sputum, saliva, bronchoscopy samples) frames for healthy individuals, including mouth and teeth;
- Establishing baselines for the respiratory tract, for example how does the normal sinus flora compare to an unhealthy, symptomatic one?;
- Developing technology to make large time series studies feasible over time;
- Developing technology for studying clonal dynamics within single species;
- Identifying pathogenesis of currently undiagnosed respiratory infections/ exacerbations and following fluctuations or adaptations of flora in the context of respiratory illness; and
- Contribution of phages and gene transfer to the microbiome, including, but not limited to, studies on antibiotic resistance.

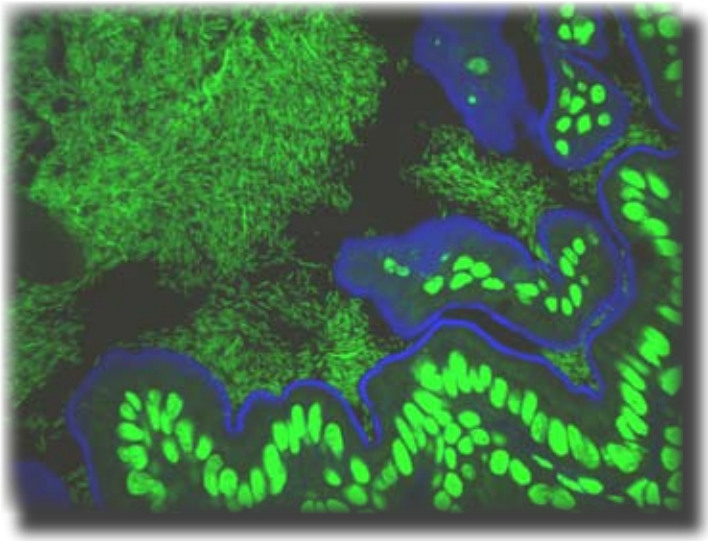
Examples of respiratory tract infections that are already being well studied in Canada and for which there is existing research capacity include: influenza, SARS, cystic fibrosis and pneumonia in the elderly. The group also highlighted the value of existing cohorts for microbiome studies, for example in cystic fibrosis and the CHILD study mentioned previously.

The group recommended a "mixed bag" of funding opportunities similar to the suite of programs launched under the Pandemic Influenza Initiative. These programs might include short term grants, training opportunities, and larger team grants - all of which could be phased in over time to allow researchers to build on their strengths.

Viruses



This group was somewhat under represented at the workshop but nevertheless felt that research into the human virome, should be an essential part of any microbiome initiative and that Canada is well placed to take advantage of our considerable research strength in this area. Scientists are continually discovering new viruses and there are increasing links being made between viruses and diseases such as cancer e.g. papilloma virus and cervical cancer, hepatitis and liver cancer, and certain autoimmune diseases, e.g. multiple sclerosis. The first metagenome studies on viruses were performed on viruses originating in the ocean and now researchers are looking as far a field as viruses in space. The human virome is as yet very poorly characterized and may represent a true Canadian niche area, as the creation of a viral "map" is likely to be important in understanding human health and disease. Studies on phage and their role as potential reservoirs of pathogenicity would also fall under this area. The group suggested that the time is now right for metagenomics to discover viruses and to asses the background level of viruses in blood, spinal fluid, urine, stool and tissue. Given the case where three individuals acquired a fatal viral infection after receiving transplants from a single donor, the area of transplantation might be a good place to begin, by collecting urine and bile from patients before and after transplant. Draining lymph nodes may also represent a good place to look for viruses. It was acknowledged that the field is in its infancy and will require capacity building support initially and perhaps targeted funds for discovery research.



Social, Legal and Ethical issues

This small group focused on issues that might be specific to human microbiome research and therefore require special attention. There was consensus that the first step should be to educate ethicists and their colleagues on the human microbiome project as, so far, it has garnered little attention in that community. It was suggested that there might be some debate generated about the difference between collecting human tissue and human waste, e.g. fecal samples, and the implications that might have on the concept of ownership. There was also discussion on the impact that research might have on the perception of identity – potentially leading to an "it's not me, it's my microbes" scenario, which could have legal ramifications. It was also mentioned that research that involved exposing neonates to microbes might lead to ethical issues and that the potential psychiatric effects of microbes might also be associated with ethical and social issues. There was also concern about the ethical implications of collecting massive amounts of sequencing data for which we have no use as yet and whether this was an ethical use of scarce resources. Overall the concept of the human microbiome might have profound implications from a legal standpoint.

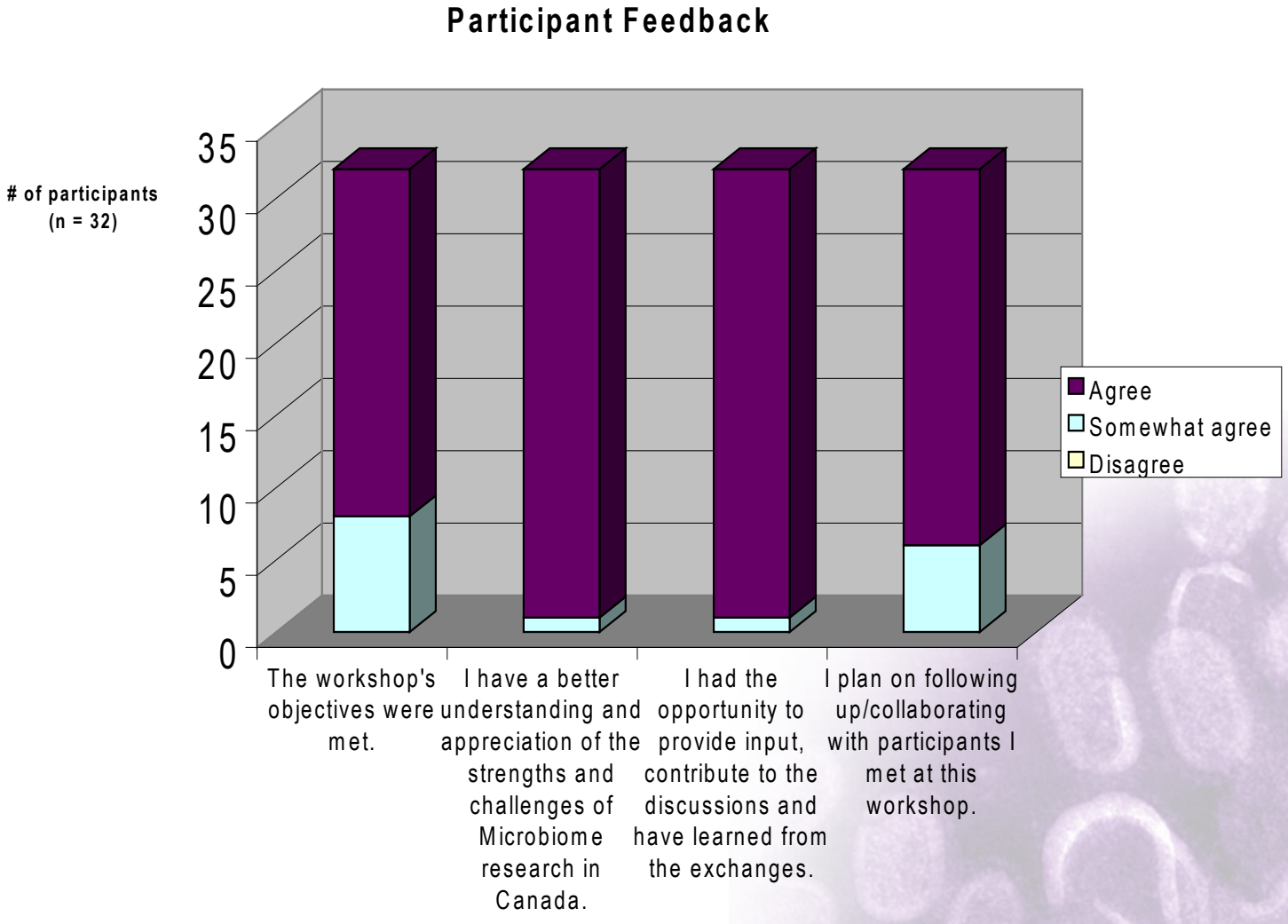
Conclusions and Next Steps

Brett Finlay led a brief discussion in which he summarized the recommendations coming from the second break out group sessions in terms of suggested next steps. The overarching recommendation was for a variety of targeted funding that would meet the diverse needs of the various groups, while forming links between them. An emphasis was placed on the identification of research areas that represent a unique Canadian niche and build on existing expertise, capacity and infrastructure. It was felt that the Canadian role should be more on the biology of the microbiome rather than the sequencing per se, although Canada has several excellent sequencing facilities across the country to draw upon. The Catalyst Grant program launched in June by III and partners should serve to provide an early "jump start" to the community and enable researchers and teams of researchers to prepare for a future funding launch to support larger, multidisciplinary teams. Karen Kennedy reiterated that, for Genome Canada, a strategic case for support of this area would need to be made, somewhat similar to a position paper, and she encouraged participants to think about working together to draft such a document. If successful, it could lead to future Genome Canada funding for large scale projects.

III, in consultation with its Institute Advisory Board and partners, and based on the recommendations received at the workshop, will decide over the coming months on the best approach to moving the initiative forward and establishing a place for Canada in the International Microbiome project.

Workshop Evaluation

The workshop evaluation was overwhelmingly positive with the majority of participants indicating that the workshop was a successful and worthwhile event. Participants remarked that the breakout sessions provided a valuable opportunity to network and raise new ideas and that the presentations provided an excellent overview of the field. Many participants also attributed the success of the workshop to the quality, diversity and intellectual range of participants who attended the workshop. The workshop was viewed as an "excellent opportunity to network with other researchers in this area" and the majority of participants indicated that they plan to follow up on potential collaborations with colleagues they met at the workshop.



Appendix 1

Canadian Human Microbiome Workshop

Hosted by:
CIHR Institute of Infection and Immunity and
Genome Canada

Royal York Hotel - Toronto, Ontario
June 16-17, 2008

AGENDA

Day 1: Monday June 16 Ontario Room (Level C)			
14:00	**Welcome and Opening Remarks**		Brett Finlay and Judith Bray
14:15	**CIHR perspective**		Bhagi Singh
14:30	**Genome Canada perspective**		Karen Kennedy
14:45	**NIH and the Human Microbiome Project**		Jane Peterson
15:30	**Bugs "Я" Us**		Brett Finlay
15:50	**Microbial Communities: Challenges and Frontiers**		Mike Surette
16:10	**Next Generation Sequencing and Metagenomics**		Ken Dewar
16:30	*Health Break*	Ontario Room (Level C)	
17:00	**Oral/Dental Microbiome**		Dennis Cvitkovitch
17:20	**Dynamic mutualism between the host commensal intestinal flora and the mucosal immune system**		Andrew Macpherson
17:40	**Probiotics**: what we know and what we need to know		Karen Madsen
18:00	*Networking Reception*	Library Room (main mezzanine level)	
19:45	*Networking Dinner*	The Sultan's Tent - 49 Front Street E	

Day 2: Tuesday June 17 Upper Canada Room (18th floor)		
08:00	*Breakfast*	The Library Room (main mezzanine floor)
9:00	**A Word From Potential Partners** Ontario Genomics Institute Lallemand – Institut Rosell Crohn's and Colitis Foundation AllerGen - Networks of Centres of Excellence (NCE)	Klaus Fiebig Thomas Tompkins George Tolomiczenko Dean Befus
9:45	**Breakout Session 1**: - Research Methods: What is our capacity in Canada and what are the challenges and opportunities?	**Group 1** - York Room **Group 2** - Library Room **Group 3 and 4** - Upper Canada Room
11:15	*Health Break*	The Upper Canada Room
11:30	**Report Back to the whole group**	Upper Canada Room
12:00	*Lunch*	The Library Room (main mezzanine floor)
13.00	**Breakout Session 2:** - Research Areas: Developing strategies and questions according to each area.	**Gastro** – Library Room **Neuro** – York Room **Naso** – Upper Canada Room **Viral** – Upper Canada Room **Ethics** – Upper Canada Room
14:00	**Report Back to the whole group**	Upper Canada Room
14:30	**Whole Group Discussion - Next Steps**	Brett Finlay
15:00	*Adjournment*	
15:30 – 16:30	**Working Group and Funders meeting**	Upper Canada Room

Appendix 2

Breakout Session 1

Breakout Group 1	Breakout Group 2
Facilitator – Michael Surette **Note Taker – Judith Bray** Jane Aubin David Bailey Dean Befus André Dascal Robert Holt Andrew Macpherson Andrew Mason Deborah Money Darryl Pullman Denis Roy Philip Sherman Simon Tran Gary Van Domselaar	**Facilitator – Brett Finlay** **Note Taker – David Hartell** Petra Arck Christian Baron Stephen Collins David Crouch Ken Dewar Richard Ellen Scott D. Gray-Owen Josée Guimond David Hwang Richard Moore Kieran O'Doherty George Tolomiczenko Pamela Valentine
Breakout Group 3	**Breakout Group 4**
Facilitator – Emma Allen-Vercoe **Note Taker – Gwen Malo** Robert Beiko John Bienenstock Richard Brière Ford Doolittle Aida Fernandes Klaus Fiebig Bartha Knoppers Gregor Reid Bhagi Singh Ted Steiner Patrick Tang Richard Wintle	**Facilitator –Allison McGeer** **Note Taker – Ursula Danilczyk** John Archibald Dennis Cvitkovitch Gary Garber David Guttman Nicola Jones Karen Kennedy Marc Ouellette Jeff Reading David Speert Curtis Suttle Thomas Tompkins Elena Verdu

Breakout Session 2

Breakout Group A –Gastrointestinal/ Probiotics/urogenital	Breakout Group B - Neurological	Breakout Group C – Respiratory/ nasopharyngeal
Facilitator – Emma Allen-Vercoe **Note Taker – Gwen Malo** David Bailey Christian Baron Robert Beiko Ken Croitoru David Crouch Ken Dewar Richard Ellen Brett Finlay Nicola Jones Andrew Macpherson Deborah Money Gregor Reid Denis Roy Philip Sherman Ted Steiner George Tolomiczenko Thomas Tompkins Elena Verdu	**Facilitator – John Bienenstock** **Note Taker – Judith Bray** Petra Arck Dean Befus Richard Brière Stephen Collins Klaus Fiebig Scott Gray-Owen Pamela Valentine Richard Wintle	**Facilitator –Allison McGeer** **Note Taker – Ursula Danilczyk** John Archibald Aida Fernandes Gary Garber Josée Guimond David Guttman David Hwang Karen Kennedy Marc Ouellette Jeff Reading David Speert Michael Surette Gary Van Domselaar
Breakout Group D – Viral	**Breakout Group E – Ethics**	
Facilitator – Andrew Mason **Note Taker – David Hartell** André Dascal Robert Holt Richard Moore Bhagi Singh Curtis Suttle Patrick Tang	Ford Doolittle Bartha Knoppers Kieran O'Doherty Darryl Pullman	

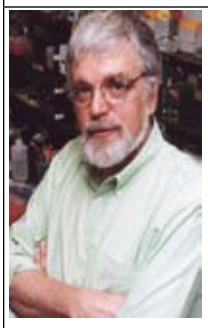
Appendix 3

List of Participants
Canadian Microbiome Workshop
Royal York Hotel, Toronto
June 16-17, 2008

Picture	Name	Contact Information	Research Interests
	**Emma Allen-Vercoe** Assistant Professor	University of Guelph Science Complex 50 Stone Road East Office: SCIE 3252 Guelph, Ontario N1G 2W1 Phone: 519-824-4120 x 53366 Fax: 519- 837-1802 Email: eav@uoguelph.ca	Normal human gut microflora, both in disease and in health. 1) developing new methodologies to culture and study novel bacterial species from the gut in order to better understand how these species might contribute to the remarkable homeostasis of the microflora community as a whole 2) determining which species of the gut microflora can behave pathogenically towards the host 3) development of model systems to study the contributions of environmental factors, such as drugs, hormones and dietary components, to microflora dysbiosis.
	**John Archibald** Associate Professor and Associate Graduate Coordinator	Department of Biochemistry & Molecular Biology Dalhousie University Sir Charles Tupper Medical Building 5850 College Street Halifax, Nova Scotia B3H 1X5 Phone: 902-494-2536 Fax: 902-494-1355 Email: john.archibald@dal.ca	Gene and genome origin and evolution; Secondary endosymbiosis and the evolution of nucleomorph genomes; Molecular evolution and systematics of microbial eukaryotes. 1) elucidating some of the pivotal molecular and biochemical events that have shaped the evolution of eukaryotic cells; 2) understanding the evolutionary relationships amongst eukaryotic microbes; and 3) understanding how eukaryotic genes, genomes and proteins change over time.
	**Petra Arck** Associate Professor Clinical Immunology and Allergy	Department of Medicine McMaster University St. Joseph's Healthcare Building 50 Charlton Ave. E., Room T3304 Hamilton Ontario L8N 4A6 Phone: 905-522-1155 x 35203 Fax: 905-540-6593 Email: arck@univmail.cis.mcmaster.ca	Neuroimmunology; psychological stress, impact on the body, pregnancy.
	**Jane Aubin** Scientific Director, CIHR Institute of Musculoskeletal Health and Arthritis	IMHA Department of Molecular Genetics Faculty of Medicine, University of Toronto The Banting Institute 100 College St., Room 207B Phone: 416-978-4220 Fax: 416-978-3954 Email: jane.aubin@utoronto.ca	IMHA supports research to enhance active living, mobility and movement, and oral health; and addresses causes, prevention, screening, diagnosis, treatment, support systems, and palliation for a wide range of conditions related to bones, joints, muscles, connective tissue, skin and teeth.

Picture	Name	Contact Information	Research Interests
	**David Bailey** President and CEO	Genome Alberta 3553-31 Street NW Suite 115 Calgary, Alberta T2L 2K7 Phone: 403-503-5220 Fax: 403-503-5225 Email: dbailey@genomealberta.ca	In partnership with Genome Canada, Industry Canada and the Province of Alberta, Genome Alberta was established in the fall of 2005 to focus on genomics as one of the central components of the Life Sciences Initiative in Alberta, and to help position the Initiative as a core research effort similar to that developed for the provincial energy and information technology sectors.
	**Christian Baron** Professor and Chair	Département de biochimie Université de Montréal C.P. 6128, Succ. Centre-Ville Montréal, Qc H3C 3J7 Phone: 514-343-6372 Fax: 514-343-2210 Email: christian.baron@umontreal.ca	Comparative genomics, functional proteomics, membrane protein complexes, biochemical, chemical biological and structure biological methods to analyze protein-protein interactions, anti-microbial and anti-infective drugs.
	**Dean Befus** Professor, Division of Pulmonary Medicine	Division of Pulmonary Medicine Department of Medicine Faculty of Medicine & Dentistry University of Alberta 550A Heritage Medical Research Centre Edmonton, Alberta Phone: 780-492-1909 Fax: 780-492 5329 Email: dean.befus@ualberta.ca	Mast cells, neuroimmunology, asthma/allergy inflammation, mucosal immunology, asthma education, health education
	**Robert Beiko** Assistant Professor	Faculty of Computer Science Dalhousie University 6050 University Avenue Halifax, Nova Scotia Canada B3H 1W5 Phone: 902 494-8043 Fax: 902 492-1517 Email: beiko@cs.dal.ca	Comparative, functional, and evolutionary genomics/bioinformatics focused mainly on bacterial evolution; comparative analysis of many DNA and protein sequences from one or more organisms; analysis of real data and modeling; metagenomics; construction of sophisticated and efficient algorithms that address the problems inherent in biological sequence data.
	**John Bienenstock** Professor Departments of Medicine & Pathology and Molecular Medicine	Department of Medicine Clinical Immunology and Allergy McMaster University St. Joseph's Healthcare Building 50 Charlton Ave. E., Room T3304 Hamilton Ontario L8N 4A6 Phone: 905-522-1155 x 35203 Fax: 905-540-6593 Email: bienens@mcmaster.ca	Immunology, immunopathology, immunophysiology of mucosal tissue. Mucosal immunology and its alteration in a variety of disease models. Allergic reactions, especially the examination of neuro-immune interactions and the reciprocal communication which occurs between these two systems. Mechanisms of effects of probiotics organisms in various models of allergic and other inflammation.
	**Judith Bray** Assistant Director Institute of Infection and Immunity, and Institute of Cancer Research	Institute of Infection and Immunity Canadian Institutes of Health Research Room 97, 160 Elgin Street Address locator: 4809A Ottawa ON K1A 0W9 Phone: 613-954-7223 Fax: 613-954-1800 Email: judith.bray@cihr-irsc.gc.ca	The CIHR Institute of Infection and Immunity (III) supports research and helps to build research capacity in the areas of infectious disease and the body's immune system. Through the Institute's programs, researchers address a wide range of health concerns related to infection and immunity including disease mechanisms, disease prevention and treatment, and health promotion through public policy.

Picture	Name	Contact Information	Research Interests
	**Richard Brière** Assistant Director CIHR Institute of Neurosciences, Mental Health and Addiction (INMHA)	INMHA Douglas Hospital Research Centre McGill University 6875 LaSalle Blvd. Perry E-2212 Verdun, Quebec H4H 1R3 Phone: 514-761-6131 x 3930 Fax: 514-888-4060 Email: richard.briere@douglas.mcgill.ca	The Institute of Neurosciences, Mental Health and Addiction (INMHA) supports research on the functioning and disorders of the brain, the spinal cord, the sensory and motor systems, and the mind.
	**Stephen Collins** Associate Dean, Research, Faculty of Health Sciences Professor, Dept. of Medicine, Gastroenterology	McMaster University Health Sciences Centre 1200 Main St. W., Room 2E16 Hamilton, Ontario L8N 3Z5 Phone: 905-525-9140 x 22184 Fax: 905-524-1346 Email: scollins@mcmaster.ca	The pathophysiology of intestinal diseases including post-infective irritable bowel syndrome. Mechanisms underlying the ability of intestinal microbiota to influence gut physiology and to influence the gut-brain axis. Specifically, the ability of gut bacteria to influence behaviour using murine models of (a) Gastrointestinal dysfunction (b) Intestinal infection/inflammation. (c) Altered behaviour. Clinical studies on Walkerton population.
	**Ken Croitoru** Professor of Medicine, Division of Gastroenterology Zane Cohen Digestive Disease Research Center - IBD Group	University of Toronto Division of Gastroenterology Mount Sinai Hospital, Room 431 600 University Avenue, Toronto, Ontario, M5G 1X5 Canada Phone: 416 586-4800 Ext 7454 Fax: 416 586-4747 Email: Kcroitoru@mtsinai.on.ca	Basic Science of Inflammatory Bowel Disease- focus on T cell biology and regulatory T cells in animal models of colitis Clinical Research in IBD - Project Leader for CCFC sponsored Multi-Centered Canadian Prospective Cohort study of Individuals at risk for Crohn's disease to identify the Genetic, Environmental and Microbial Factors triggering or causing Crohn's disease (GEM Project).
	**David Crouch** Assistant Director, CIHR Institute of Nutrition, Metabolism and Diabetes (INMD)	INMD Simon Fraser University 8888 University Drive, Room TC0200 Burnaby, BC V5A 1S6 Phone: 778-782-6747 Fax: 778-782-3055 Email: david.crouch@cihr-irsc.gc.ca	INMD supports research to enhance health in relation to diet, digestion, excretion, and metabolism; and to address causes, prevention, screening, diagnosis, treatment, support systems, and palliation for a wide range of conditions and problems associated with hormone, digestive system, kidney, and liver function.
	**Dennis Cvitkovitch** Associate Professor, Oral Microbiology	Rm 449A, Faculty of Dentistry University of Toronto 124 Edward Street Toronto, Ontario M5G 1G6 Phone: 416-979-4917 x 4592 Fax: 416-979-4936 Emails: d.cvitkovitch@dentistry.utoronto.ca	The role of the acid tolerance response of *Streptococcus mutans,* the principal agent of dental caries; the mechanisms of cell-cell signalling and its role in biofilm formation and genetic exchange by gram positive pathogens; potential vaccine targets for *Streptococcus pyogenes* infections; and the effects of dental restorative materials on bacterial growth and metabolism.

Picture	Name	Contact Information	Research Interests
	**Ursula Danilczyk** Assistant Director, CIHR Institute of Genetics (IG)	IG 123 Edward Street, Suite 1211 Toronto, ON M5G 1E2 Phone: 416-813-7670 Fax: 416-813-7673 Email: ursulaig@sickkids.ca	IG supports research on the human genome and in all aspects of genetics, basic biochemistry and cell biology related to human health and disease, including interaction of genes with physical and social environments.
	**André Dascal** Associate Professor; Medical Microbiology	Department of Microbiology Division of Infectious Diseases McGill University Jewish General Hospital 3755 Cote St. Catherine Road Montreal, QC H3T 1E2 Phone: 514-340-8294 Fax: 514-340-7508 Email: andre.dascal@mcgill.ca	Rapid viral and bacterial identification, antimicrobial susceptibility testing, cost effective diagnostic microbiology.
	**Ken Dewar** Associate Professor, Department Human Genetics	McGill University and Genome Quebec Innovation Centre 740 Ave. Dr. Penfield, Rm 7214 Montréal, QC H3A 1A4 Phone: 514-398-3311 x 00089 Fax: 514-398-1738 Email: ken.dewar@mcgill.ca	Large scale sequencing and analysis; comparative genomics; generation and analysis of genomic sequences to increase understanding of mammalian evolution and development.
	**Ford Doolittle** Professor	Department of Biochemistry and Molecular Biology Dalhousie University Sir Charles Tupper Building, Room 8C 5850 College Street Halifax, NS B3H 1X5 Phone: 902-494-3569 Fax: 902-494-1355 Email: ford@dal.ca	Evolution of genes and genomes; reconstruction of phylogenies from gene sequences using standard methods of molecular genetics and sophisticated computer algorithms; introns; origins of eukaryotic genomes; early events (gene duplications) in eukaryotic nuclear genome evolution; role of lateral gene transfer in evolution; neutral models for the evolution of molecular complexity; and environmental microbiology
	**Richard Ellen** Professor Faculties of Dentistry and Medicine	CIHR Group in Matrix Dynamics University of Toronto Faculty of Dentistry 124 Edward St. Toronto, ON M5G 1G6 Phone: 416-979-4917 x 4456 Fax: 416-979-4936 Email: richard.ellen@dentisitry.utoronto.ca	Oral microbial ecology; the biology of spirochetes; the pathogenesis of periodontal diseases; pathogenic biofilms; cellular microbiology; cell signaling in mucosal inflammation & pain; Treponema denticola outer sheath proteins and their perturbation of actin dynamics in fibroblasts and chemotaxis of neutrophils
	**Aida Fernandes** Director, Medical / Scientific and Community Programs	Canadian Cystic Fibrosis Foundation 2221 Yonge Street, Suite 601 Toronto, Ontario M4S 2B4 Phone: 416-485-9149 x 229 Fax: 416-485-0960 Email: afernandes@cysticfibrosis.ca	The Foundation's mission is to help people with cystic fibrosis (CF). The Foundation funds research towards the goal of a cure or control for CF, and supports high quality CF care; promotes public awareness of CF; and raises and allocates funds for these purposes.

Picture	Name	Contact Information	Research Interests
	**Klaus Fiebig** Chief Scientific Officer & Vice President, Research Programs Ontario Genomics Institute	Ontario Genomics Institute MaRS Centre, Heritage Building 101 College Street, Suite HL50 Toronto, ON M5G 1L7 Phone: 416-673-6583 Fax: 416-977-8342 Email: kfiebig@OntarioGenomics.ca	The Ontario Genomics Institute (OGI) is a non-profit corporation with a mission to provide leadership for Ontario in helping build a globally-competitive life sciences sector by creating leverageable genomics resources with top-notch research. OGI is part of the new MaRS Discovery District, serving the innovation pipeline in Ontario.
	**Brett Finlay** Professor, Michael Smith Laboratories	#301 - 2185 East Mall University of British Columbia Vancouver, British Columbia V6T 1Z4 Phone: 604-822-2210 Fax: 604-822-9830 E-mail: bfinlay@interchange.ubc.ca	Host-pathogen interactions, at the molecular level; cellular microbiology; pathogenic bacteria, with Salmonella and pathogenic *E. coli* interactions with host cells being the primary focus.
	**Gary E. Garber** Head, Division of Infectious Diseases Professor of Medicine and of Biochemistry Microbiology and Immunology	Ottawa Health Research Institute 725 Parkdale Ave. Ottawa ON K1Y 4E9 Phone: 613-737-8173 or 613-737-8169 Email: ggarber@ohri.ca	Appropriate use of antibiotics and evaluating novel antibiotics and antifungal agents in nosocomial infection; the pathogenesis of Trichomonas vaginalis and mouse model of vaginal infections. Representing CIHR-Institute of Gender and Health. IGH supports research that addresses how sex and gender influence health.
	**Scott Gray-Owen** Professor, Department of Molecular Genetics	Medical Sciences Building, Room 4381 University of Toronto 1 King's College Circle Toronto, Ontario M5S 1A8 Phone: 416-946-5307 Fax: 416-978-6885 Email: scott.gray.owen@utoronto.ca	Cellular, molecular and immunologic response of humans to the pathogenic Neisseria; Molecular interactions between human-restricted bacterial pathogens and host cellular receptors; Bacterial evasion of innate and adaptive immunity.
	**Josée Guimond** Director, Research Programs and Partnerships	Canadian Diabetes Association - National Office 1400 - 522 University Avenue Toronto, ON M5G 2R5 Phone: 416-408-7083 Fax: 416-363-7465 Email: josee.guimond@diabetes.ca	Canadian Diabetes Association: Established over 50 years ago, the Canadian Diabetes Association is a charitable organization that has grown to include a presence in more than 150 communities across the country. The Canadian Diabetes Association promotes the health of Canadians through diabetes research, education, service and advocacy.
	**David Guttman** Director, Centre for the Analysis of Genome Evolution & Function Associate Professor	Department of Cell & Systems Biology Department of Ecology & Evolutionary Biology University of Toronto 25 Willcocks St. Toronto, ON M5S 3B2 Phone: 416-978-6865 Fax: 416-978-5878 Email: david.guttman@utoronto.ca	Evolution of host specificity and virulence; comparative genomics; metagenomics; evolution and ecology of the Pseudomonads;

Picture	Name	Contact Information	Research Interests
	**David Hartell** Associate Institute Strategic Initiatives, Institute of Infection(III) and Immunity, Institute of Cancer Research	Canadian Institutes of Health Research Room 97, 160 Elgin Street Address locator: 4809A Ottawa ON K1A 0W9 Phone: 613-941-4329 Fax : 613-954-1800 E-mail: david.hartell@cihr-irsc.gc.ca	The CIHR Institute of Infection and Immunity (III) supports research and helps to build research capacity in the areas of infectious disease and the body's immune system. Through the Institute's programs, researchers address a wide range of health concerns related to infection and immunity including disease mechanisms, disease prevention and treatment, and health promotion through public policy.
	**Robert Holt** Head, Sequencing, Genome Sciences Centre	Genome Sciences Centre BC Cancer Research Centre location 675 West 10th Avenue Vancouver, BC V5Z 1L3 Phone: 604-877-6276 Fax: 604-877-6085 or 604-733-9481? Email: rholt@bcgsc.ca	Synthetic Biology; development of laboratory methods for constructing large DNA molecules, engineering whole microbial genomes and exploring microbial genome interaction; evolutionary biology (exploring gene duplication in primates and other model systems, with a particular focus on brain evolution); neurobiology (using DNA sequence analysis, microsattelite analysis, genomic microarrays, and IP/MS to explore candidate genes for complex psychiatric disease); technology development in DNA sequencing.
	**David Hwang** Assistant Professor	Department of Pathology University of Toronto Toronto General Hospital, Room 11E423 200 Elizabeth St. Toronto, ON M5G 2C4 Phone: 416-340-3345 Fax: 416-586-9901 Email: David.hwang@uhn.on.ca	Mechanisms of lung regeneration and repair; metagenomic characterization of the pulmonary microbiota in cystic fibrosis and other chronic lung diseases.
	**Nicola Jones** Associate Professor Paediatrics	The Hospital for Sick Children Division of Gastroenterology, Hepatology and Nutrition 555 University Avenue Toronto, Ontario M5G 1X8 Phone: 416-813-7734 Fax: 416-813-5028 Email: nicola.jones@sickkids.ca	Disease pathophysiology following Helicobacter pylori infection; mechanisms H. pylori utilizes to subvert host immune responses thereby resulting in disease.
	**Karen Kennedy** Director, International Genomics Programs	Genome Canada 150 Metcalfe Street, Suite 2100 Ottawa, Ontario K2P 1P1 Phone: 613-751-4460 x 134 Fax: 613-751-4474 Email: kkennedy@genomecanada.ca	The mandate of Genome Canada is to develop and implement a national strategy in genomics and proteomics research for the benefit of all Canadians in the areas of health, agriculture, environment, forestry and fisheries. Genome Canada provides funding to support large-scale research projects through the regional Genome Centres established across the country. Genome Canada also provides funding to support research on the ethical, environmental, economic, legal and social (GE3LS) issues related to genomics and proteomics research .

Picture	Name	Contact Information	Research Interests
	**Bartha Knoppers** Professor of Law, Université de Montréal Canada Research Chair in Law and Medicine	Pavillon Maximilien Caron Université de Montréal 3101 chemin de la Tour, Rm A-9430 Montréal, QC H3T 1J7 Phone: 514-343-6714 Fax : 514 343-2122 Email: bartha.maria.knoppers@.umontreal.ca	Ethical and legal issues in the field of genomic research and population health. Will assist in defining national and international policies to guide the actions of industries, researchers and governments.
	**Andrew Macpherson** Professor, Department of Medicine	1200 Main St. W. Room 4W8 McMaster University Hamilton, ON L8N 3Z5 Phone: 905-521-2100 x 76768 Fax: 905-521-4958 Email: macpher@mcmaster.ca	Mucosal immunology; role of microbes in shaping the immune response; mechanisms by which the intestine's immune system protects against damage from our own intestinal bacteria and how antibodies in mother's milk protect the infant as its immune system develops.
	**Karen Madsen** Professor, Division of Gastroenterology	Faculty of Medicine & Dentistry University of Alberta 6146 Dentistry Pharmacy Building University of Alberta Edmonton, Alberta T6G 2N8 Phone: 780-492-5257 Fax: 780-407-3744 Email : karen.madsen@ualberta.ca	Determination of the role of both bacteria and intestinal permeability in the pathogenesis of Crohn's disease; the breakdown of mucosal barrier integrity; repair of the mucosal barrier; the role of the nuclear enzyme, poly-ADPribose polymerase, in the breakdown of barrier integrity and how to inhibit this enzyme so intestinal permeability returns to normal.
	**Gwendoline Malo** Associate Institute Strategic Initiatives, Institute of Infection and Immunity, and Institute of Cancer Research	Canadian Institutes of Health Research Room 97, 160 Elgin Street Address locator: 4809A Ottawa, ON K1A 0W9 Phone: 613-948-2773 Fax : 613-954-1800 E-mail: gwendoline.malo@cihr-irsc.gc.ca	The CIHR Institute of Infection and Immunity (III) supports research and helps to build research capacity in the areas of infectious disease and the body's immune system. Through the Institute's programs, researchers address a wide range of health concerns related to infection and immunity including disease mechanisms, disease prevention and treatment, and health promotion through public policy.
	**Andrew Mason** Associate Professor Gastroenterology	Department of Medicine University of Alberta 1-28A Zeidler Ledcor Centre Edmonton, AB T6G 2X8 Phone: 780-492-8176 Fax: 780-492-1655 Email: andrew.mason@ualberta.ca	Viral induction of autoimmune liver disease; virus discovery; anti-viral therapy for autoimmune liver disease; viral hepatitis; general hepatology; transplant hepatology. Metagenomic analysis for viral discovery and description of the human virome
	**Allison McGeer** Microbiologist, Infectious Disease Consultant	Department of Microbiology, Room 210 Mount Sinai Hospital 600 University Ave, Toronto Ontario, M5G 1X5 Phone: (416) 586-3118 Fax: (416) 586-3140 Email: amcgeer@mtsinai.on.ca	Internal medicine, infectious diseases and hospital epidemiology; Prevention of infection in hospitals and nursing homes; use of surveillance to advance the prevention, diagnosis and treatment of infectious diseases; epidemiology of severe community-acquired infections.

Picture	Name	Contact Information	Research Interests
	**Deborah Money** Assistant Professor, Department of Obstetrics & Gynaecology, UBC; and Executive Director, Women's Health Research Institute	Women's Health Research Institute E204 - 4500 Oak Street Vancouver, BC V6H 3N1 Phone: 604-875-3459 Fax: 604-875-3895 Email: dmoney@cw.bc.ca	Research in Infectious Diseases in Obstetrics and Gynecology, focused on viral pathogens in women and in pregnancy, specifically HIV, HPV, Hepatitis C and genital herpes.
	**Richard Moore** Sequencing Group Leader Research Associate, Genome Sciences Centre	Genome Sciences Centre BC Cancer Research Centre location 675 West 10th Avenue Vancouver, BC V5Z 1L3 Phone: 604-877-6098 x 2599 Fax: 604-675-8178 Email: rmoore@bcgsc.ca	Genome mapping and DNA sequencing. Infectious agents and their association with human disease, a particular interest in cancer causing viruses including HPV.
	**Jane Peterson** Associate Director, NHGRI Division of Extramural Research and Program Director, Human Microbiome Project	National Human Genome Research Institute (NHGRI) 5635 Fishers Lane, Suite 4076 Bethesda, MD 20892 Phone: 301-496-7531 Fax: 301-480-2770 Email: Jane_Peterson@nih.gov	The National Human Genome Research Institute led the Human Genome Project for the National Institutes of Health, which culminated in the completion of the full human genome sequence in April 2003. Now, NHGRI moves forward into the genomic era with research aimed at improving human health and fighting disease.
	**Kieran O'Doherty** Post-doctoral Research Fellow	W. Maurice Young Centre for Applied Ethics University of British Columbia 227 - 6356 Agricultural Road Vancouver, B.C. V6T 1Z2 Phone: 604-827-4553 Fax: 604.822.8627 Email: kcodoher@interchange.ubc.ca	Risk communication; probability; genetic counselling; consumer behaviour; Public participation in science policy; social categorization; causal reasoning
	**Marc Ouellette** Professor, Microbiology	Centre de Recherche en Infectiologie Université Laval CHUQ, pavillon CHUL, local RC-709 2705 boul. Laurier Québec QC G1V 4G2 Phone: 418 654-2705 Fax: 418 654-2715 Email: Marc.Ouellette@crchul.ulaval.ca	Antimicrobial resistance (resistance mechanism in protozoan parasites); proteomic and DNA microarray strategies to study antimicrobial resistance in the parasite Leishmania and the bacteria Streptococcus pneumoniae; Alternatives to antimicrobials (e.g. phages). Dr. Ouellette is a member of III's Institute Advisory Board.
	**Daryl Pullman** Professor of Medical Ethics Memorial University	Faculty of Medicine Division of Community Health and Humanities Memorial University St. Johns, Newfoundland A1B 3V6 Phone: 709-777-6220 Fax: 709-777-7382 Email: dpullman@mun.ca	Research ethics; ethics and aging; privacy and access to health information; issues related to genetic research and therapy; the concept of human dignity and its foundational role in moral epistemology.

Picture	Name	Contact Information	Research Interests
	**Jeff Reading** Scientific Director, CIHR Institute of Aboriginal Peoples' Health	Institute of Aboriginal Peoples' Health University of Victoria Saunders Annex, Room 130C 3800 Finnerty Road Victoria, BC V8P 5C2 Phone: 250-472-5449 Fax: 250-472-5450 E-mail: jreading@uvic.ca	The CIHR Institute of Aboriginal Peoples' Health supports research to address the special health needs of Canada's Aboriginal people. Its role is to lead a national advanced research agenda in the area of aboriginal health and promote innovative research that will serve to improve the health of aboriginal people in Canada.
	**Gregor Reid** Scientist, Lawson Health Research Institute Professor of Microbiology and Immunology, and Surgery at UWO	Lawson Health Research Institute 268 Grosvenor Street, London, Ontario N6A 4V2 Phone: 519-646-6100 x 65256 Fax: 519-646-6110 Email: gregor@uwo.ca	Development of novel therapies based upon beneficial bacterial (probiotics) for application to the intestinal and urogenital tracts, and distant sites; genomic and functional analysis of probiotic *lactobacilli*; mechanisms of *lactobacilli* anti-infective effects; national and international human trials.
	**Denis Roy** Canada Research Chair Tier 1 Full Professor Molecular Microbiology Food Science and Nutrition Dept.	Institut des nutraceutiques et des aliments fonctionnels (INAF) Pavillon des Services, local 2746 Université Laval Québec, QC G1K 7P4 Phone : 418-656-2131 x 3098 Fax: 418-656-5877 Email: denis.roy@fsaa.ulaval.ca ; denis.roy@inaf.ulaval.ca	Probiotic bacterial metabolic activity in dairy fermented products; genotyping of probiotic bacterial strains; transcriptional analysis of bacterial strain activity; physiological and genetic study of exopolysaccharide production by lactic acid bacteria; food microbial ecosystem genomics.
	**Steve Scherer** Senior Scientist, Director, Centre for Applied Genomics ; Professor, Molecular and Medical Genetics, U of T	The Centre for Applied Genomics The Hospital for Sick Children 14th Floor, Toronto Medical Discovery Tower/MaRS 101 College St., Toronto, Ontario M5G 1L7 Phone: 416-813-7613 Fax: 416-813-8319 Email : steve@genet.sickkids.on.ca	Understanding the composition of the human genome for studies of genetic disease; structural and copy number variation in the human genome; the role genetics plays in autism; the study of human chromosome 7 as a model of the chromosomal basis of disease; and building genomics infrastructure to facilitate biomedical research.
	**Philip Sherman** Senior Scientist, Cell Biology Research Program Professor of Paediatrics, Microbiology & Dentistry U of Toronto	Cell Biology Research Program The Hospital for Sick Children 555 University Ave., Room 7142, Elm Wing Toronto, ON M5G 1X8 Phone: 416-813-7734 Fax: 416-813-6531 e-mail: philip.sherman@sickkids.ca	Gastrointestinal epithelial cell responses to bacterial pathogens and their products; Shigatoxin - producing *Escherichia coli*; paediatric inflammatory bowel disease; probiotics ; signal transduction

Picture	Name	Contact Information	Research Interests
	**Bhagi Singh** Scientific Director, CIHR Institute of Infection and Immunity	CIHR Institute of Infection and Immunity Suite 214 Siebens-Drake Research Institute The University of Western Ontario 1400 Western Road London ON N6G 2V4 Phone: 519-661-3228 Fax: 519-661-4226 Email: bsingh@uwo.ca	The CIHR Institute of Infection and Immunity (III) supports research and helps to build research capacity in the areas of infectious disease and the body's immune system. Through the Institute's programs, researchers address a wide range of health concerns related to infection and immunity including disease mechanisms, disease prevention and treatment, and health promotion through public policy.
	**David Speert** Professor and Head, Division of Infectious and Immunological Diseases, Department of Pediatrics, UBC	BC Children's Hospital Room 377 Research Centre 950 West 28th Avenue Vancouver BC V5Z 4H4 Phone: 604-875-2438 Fax: Email: dspeert@cw.bc.ca	Infection of the lung in patients with cystic fibrosis; pathogenesis of *Pseudomonas aeruginosa* ; pathogenesis of *Burkholderia cepacia* complex ; innate host defence mechanisms, particularly of the lung ; molecular epidemiology of bacterial infection.
	**Ted Steiner** Associate Professor, Faculty of Medicine, Division of Infectious Diseases	Division of Infectious Diseases University of British Columbia D452, HPE, VGH 2733 Heather Street, Vancouver, BC V5Z 3J5 Phone: 604-875-4111 x 68492 Fax: 604-875-4013 Email: tsteiner@interchange.ubc.ca	Inflammatory response to bacterial flagellin, including structure/function analyses of flagellin and Toll-like receptor 5 (TLR5) to discover the nature of their interaction; studies of inflammatory signaling by TLR5, particularly with regard to Interleukin-8 release; Studies of the role of flagellin immune responses in inflammatory bowel disease; Studies of pathogenesis of enteroaggregative *E. coli* (EAEC) infection.
	**Michael Surette** Professor, Departments of Microbiology / Biochemistry	Microbiology and Infectious Diseases Medicine Heritage Medical Research Building University of Calgary 3330 Hospital Drive N.W. Calgary, AB. T2N 4N1 Phone: 403-220-2744 Fax: 403-270-2772 Email: surette@ucalgary.ca	Structure, dynamics and evolution of bacterial communities in pathogenesis; adaptability of bacteria - regulation of gene expression; the interactions of pathogens with the normal microorganisms of the host; and the role of bacterial communication in disease.
	**Curtis Suttle** Associate Dean of Science Professor of Earth & Ocean Sciences, Microbiology & Immunology, and Botany	Biological Sciences 1324 Lab Room 1321 Dean's office Science The University of British Columbia 2329 West Mall, Vancouver, BC V6T 1Z4 Phone: 604-822-8610 Email: csuttle@eos.ubc.ca	Diversity, evolution and function of natural virus and phage communities using genomic and metagenomic approaches.

Picture	Name	Contact Information	Research Interests
	**Patrick Tang** Medical Microbiologist, BCCDC; Clinical Assistant Professor, Pathology and Laboratory Medicine, UBC	BC Centre for Disease Control 655 West 12th Avenue Vancouver, BC, V5Z 4R4 Phone: 604-660-3231 Fax: 604-660-1360 Email: patrick.tang@bccdc.ca	Genomics-based methods for the laboratory diagnosis of infectious diseases; microarrays for virus detection; integrating molecular epidemiology with bioinformatics; discovery of novel infectious agents.
	**George Tolomiczenko** Executive Director of the CCFC Inflammatory Bowel Disease Research Institute and Scientific Liaison	Crohn's and Colitis Foundation 600-60 St. Clair Avenue East Toronto, ON M4T 1N5, Phone: 416-920-5035 x 214 Fax: 416-929-0364 Email: gtolomiczenko@ccfc.ca	The Crohn's and Colitis Foundation of Canada (CCFC) is a national not-for-profit voluntary medical research Foundation. Its mission is to find the cure for inflammatory bowel disease. To achieve its mission, the Foundation is committed to raising increasing funds for medical research. The CCFC is one of the world's leaders in non-governmental, per capita funding of IBD research. To date, the Foundation has invested nearly $50 million in major medical research projects.
	**Thomas Tompkins** Director Institut Rosell-Lallemand Inc.	Institut Rosell-Lallemand Inc. 8480 Saint-Laurent Blvd. MONTRÉAL, Quebec H2P 2M6 Phone: 514-858-4633 Fax: 514-383-4493 Email: ttompkins@lallemand.com	Institut Rosell Inc., a division of Lallemand Inc., is a privately-held Canadian company providing pharmaceutical grade probiotic microbes for human health to an international market. Institut Rosell Inc. has a very active research and development program and is a considered a scientific leader in this field. We examine pre-clinical and clinical efficacy or these microbes in maintaining intestinal health, vaginal and urinary tract health and reducing allergic disorders in internal research labs and through strong collaborations with key opinion leaders from various international universities and institutes.
	**Simon Tran** Assistant Professor Faculty of Dentistry	Biomedical Sciences Faculty of Dentistry STRATHCONA Anatomy & Dentistry Building 3640 University Street Montreal, Quebec H3A 2B2 Phone: 514-398-7203 x 09182 Fax: 514-398-8900 Email: simon.tran@mcgill.ca	Dental diseases; cell biology and tissue engineering.
	**Pamela Valentine** Director, Grants and Awards	Alberta Heritage Foundation for Medical Research Suite 1500, 10104 - 103 Avenue Edmonton, Alberta T5J 4A7 Phone: 780-423-5727 Fax: 780-429-3509 Email: Pamela.valentine@ahfmr.ab.ca	The Alberta Heritage Foundation for Medical Research supports a community of researchers who generate knowledge, the application of which improves the health and quality of life of Albertans and people throughout the world. AHFMR funds health research based on international standards of excellence and carried out by new and established investigators and researchers in training.

Picture	Name	Contact Information	Research Interests
	**Gary Van Domselaar** Head, Bionformatics, National Microbiology Laboratory - PHAC	National Microbiology Laboratory Public Health Agency of Canada 1015 Arlington Street Winnipeg, Manitoba R3E 3R2 Phone: 204-784 5994 Fax: 204-789 2018 Email: gary.vandomselaar@gmail.com	Development of algorithms, software and systems for prokaryotic genome annotation and analysis; pyrosequencing and assembly of viral quasispecies populations; rapid pan-pathogen detection systems via metagenomics analysis. Founding member and Associate Director of The Bioinformatics Organization, Inc. an organization which facilitates world-wide communications and collaborations between practicing and neophyte bioinformatic scientists and technicians .
	**Elena F. Verdu** Assistant Professor, Department of Medicine	Health Sciences Centre McMaster University 1200 Main St. W., Rm 3N8 Hamilton, Ontario L8N 3Z5 Phone: 905-525-9140 x 20051 Fax: 905-522-3454 Email: verdue@univmail.cis.mcmaster.ca	Intestinal Disease Research; pathogenesis of chronic inflammatory disorders such as celiac disease; host-bacterial interactions in the context of probiotics and functional gastrointestinal diseases.
	**Richard Wintle** Assistant Director	The Centre for Applied Genomics The Hospital for Sick Children MaRS Centre - East Tower 101 College Street, Room 14-706 Toronto, Ontario M5G 1L7 Phone: 416-813-7654 x 4877 Fax: 416-813-8319 Email: rwintle@sickkids.ca	TCAG provides open access to cost-recovery genomics services available to all researchers. Personal research interests: molecular biology, human genetics research, genomic copy number variation.