The Benefits and Barriers to Interdisciplinary Research in the Health Sciences in Canada

Framework Document
September 19, 2005

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Executive Summary

The present document responds to the request by the CAHS to design and implement an assessment of the benefits and barriers to interdisciplinary health research (IDHR) in Canada. It was developed by a panel of national experts representing the 6 health sciences disciplines as well as government and industry. While there is a great deal of recent interest and literature on the concept of "inter-professional *practice*", it is beyond the scope of this assessment, which deals strictly with aspects of the *research* enterprise within and across all six disciplines.

As a framework, the document is divided into two sections: Part one is a case statement for the assessment while Part 2 proposes some of the key areas of enquiry and the types of investment necessary to undertake the study. Areas of enquiry include assessing IDHR in: Academics; Granting agencies; Government; Industry, Professional Societies; along with a look at the uniquely Canadian situation for IDHR and the ways in which research outputs are/should be measured.

Nine study projects are proposed, corresponding to each area of enquiry. It is anticipated that some of these study projects will be of interest to partners such as CIHR, NCEs or Health Canada, who may wish to support one or more components of the research.

The panel understands this framework to be an iterative process in order to refine and frame the final research questions and methodologies – particularly where partner organisations are involved. Consequently, the draft timeline for the assessment prioritises, fundamental groundwork and basic data collection needs to be determined before any of the substantive questions are addressed in any detail.

1   Case Statement for CAHS Assessment

1.1   Introduction

Background

In the spring of 2004, the newly formed Canadian Academy of Health Sciences (CAHS) looked forward to the formation and funding of the Canadian Academies of Science (CAS). The CAHS brought together the six health disciplines (Dentistry, Medicine, Nursing, Pharmacy, Rehabilitation Medicine and Veterinary Medicine). As an inaugural activity, the provisional board of CAHS proposed to undertake a formal assessment that could stimulate policy dialogue, while demonstrating the methodology and value of the assessment process.

As leaders of each of the six disciplines came together, they realised that many of them had not worked together on research projects previously. They chose the topic "The Benefits and Barriers to Interdisciplinary Health Science Research in Canada" for the first assessment with the deliberate intention of engaging all six disciplines, enhancing interdisciplinary research in the health sciences, and helping to define the process(es) by which assessment would be done in the future CAHS.

While the act of involving its members was considered an important learning and engagement opportunity for the CAHS, the chosen topic of assessment is not insignificant. In fact, the question of how to facilitate interdisciplinary health research (IDHR) has become increasingly important in recent years as inter-professional training and practice are gaining ground at institutions across Canada. In addition, we need only consider the examples of SARS, obesity or other urgent public health issues to immediately understand the impact of what many disciplines working together can bring to the solutions.

Clearly, academia, government and industry are increasingly convinced that certain problems and research questions are best addressed through an interdisciplinary approach. However, training, recognition, funding and evaluation are challenging in most settings. A recent assessment of interdisciplinary research by the Institute of Medicine in the US identifies many common issues, but the structures and implications for policy are likely to be quite different in Canada. Indeed, preliminary literature review and case studies suggest that colleting Canadian data may be necessary (i.e. inventory of training programs, types of research being done, facilitating/inhibiting policies and structures etc). Thus, it is recognised that an assessment of the benefits and barriers to IDHR in Canada has broad implications and applications for policy, training, enhancing research capacity, professional development and recognition, as well as career advancement, and satisfaction. It is likely that the assessment will involve many phases, including formulation of the appropriate research questions, approach to the research (consultant, surveys, etc.), the research panel reflection, a symposium (several?), enlargement of Canadian models, draft documents, feedback, dissemination, and on going tracking. An important part of an assessment will be engaging stakeholders and the public in a national dialogue.

Assessment panel

The CAHS provisional board requested that Dr. Judith G Hall chair this assessment. Dr. Hall had previously been on the Council of the Canadian Institute of Academic Medicine (CIAM) during the formative period of the CAHS and is a senior academician, paediatrician and clinical geneticist.

The provisional council representing all 6 of the disciplines within the CAHS then identified outstanding researchers, experienced in IDHR across Canada. In addition to intending to represent all 6 disciplines, the panellists are broadly based geographically, represent a range of ages and are well balanced by gender. Assessment panel members are:
Dr. Alison Buchan, Associate Dean Research, Faculty of Medicine UBC
Professor Lesley Bainbridge, Director, School of Rehabilitation Sciences UBC
Dr. Alastair Cribb, Professor, Department of Biomedical Sciences, UPEI
Dr. David Davis, Associate Dean, Continuing Education, Faculty of Medicine, U of T
Dr. Jane Drummond, Professor, Faculty of Nursing, U of A
Dr. Carlton Gyles, Professor, Department of Pathobiology, Ontario Veterinary College
Dr. Philip Hicks, President, Nova Scotia Agricultural College
Dr. Andreas Laupacis, President, Institute for Clinical Evaluative Sciences, Faculty of Medicine U of T.
Dr. Carol McWilliam, Professor, Nursing, UWO
Dr. Barbara Lee Paterson, Tier 1 Canada Research Chair, Faculty of Nursing, UNB
Dr. Pamela Ratner, Professor, School of Nursing, UBC
Dr. Elizabeth Skarakis-Doyle, Professor Communication Sciences, UWO
Dr. Patty Solomon, Professor, Physiotherapy, McMaster U.
Dr. Judith Hall, Professor Emeritus Pediatrics and Medical Genetics, UBC

These panel members were selected because of their expertise and experience in IDHR. Six panellists are founding members of the CAHS, including the Chair. In addition, the panel will have a public member, as well as representation from Quebec and dentistry. Any conflicts of interest have been identified and recorded (such as institutional and research affiliations, etc), and the panel is expected to function independently.

Members of the assessment panel have met several times by telephone conference call, by e-mail, and once in person.

Support for this initial phase has been from CIAM. A report will be made to CIAM at the inaugural CAHS meeting in September 2005.

Mandate

In the process of identifying benefits and barriers to IDHR, the assessment panel identified the following areas for further development into research for this assessment:
1) Define IDHR with emphasis on translational research and health science.
2) What are the benefits and unique outcomes of IDHR in academics, government and industry? What are the implications for research, training, promotion, incentives, and rewards?

3) How do various audiences, including the public, understand and use IDHR?
4) What is unique (and beneficial) about doing IDHR in Canada?
5) How can IDHR be facilitated in Canada?
6) What is the optimal way to evaluate IDHR - from the perspective of granting agencies, university departments, etc?

Overview of framework document

The balance of **Part 1** presents the 'case statement' that outlines what is known about the various issues to be assessed. This case statement is based on both a review of the relevant literature and the experiences of the assessment panel members. It lays the foundation for assessment by first presenting the rationale and then exploring the various issues that arise in discussions of interdisciplinary work in academics, government and industry. Following this, there is a brief presentation of salient Canadian experiences, each chosen to highlight both the unique aspects, along with the challenges and benefits of conducting IDHR in Canada. The last two chapters in this section develop the issues of what it takes to facilitate IDHR along with how it should be evaluated in a variety of contexts, including academic promotion or grant selection committees.

Each of the chapters outlined above have corresponding sections within **Part 2** of the document, which is designed as a *Framework for Assessment.* Briefly, Part 2 is meant to take up the issues explored in Part 1 and reframe these as research questions to be studied within the context of a formal CAHS assessment. For instance, echoing and expanding the chapter of Part 1 on IDHR in academics, three separate chapters of Part 2 each explore different aspects of the "academic question" and then propose a preliminary research design to accomplish this. Similarly, the balance of Part 2 asks the questions and proposes the research design to further explore the questions that arise throughout Part 1 such as: how to assess what is unique about IDHR in Canada? How best to evaluate IDHR in a variety of contexts? Throughout Parts 1 and 2, helpful textboxes direct the reader to consider some of the immediate implications and recommendations that flow from the discussion and that will be enriched through the proposed assessment.

Finally, **Part 3**, the document's appendices are presented in 4 separate modules that can stand alone and be circulated or adapted according to need. For instance, Appendices 3.1 can be directed toward decision-makers in granting agencies, universities, government or industry who are interested in immediate measures that can help facilitate IDHR. These preliminary recommendations are grounded in the experience of the assessment panel members, while the proposed assessment will serve to illustrate specific examples that can lead to more targeted and sustainable change.

Other items included among the appendices are a useful list of 'clients' for the IDHR assessment in Canada, who might be partners and/or funders of the assessment. There are also a list of references and selected case examples that help to ground the theoretical discussion with practical implications. As well, the most preliminary draft form of recommendations that will need to be substantiated by research are included.

Taken together, *Parts 1, 2* and the *Appendices*, are meant to present the justification and the guiding framework to conduct a formal CAHS assessment designed to stimulate dialogue and policy development to foster interdisciplinary health research in Canada.

> **Assessment Panel Working Definition (June 2005):**
> *"Interdisciplinary research involves a team of researchers from different disciplines that comes together around an important and challenging issue, the research question(s) for which is/are determined by a shared understanding in an interactive and iterative process"*

Over the past few decades researchers have worked primarily in isolation, or with research colleagues of their own discipline (Long, 2001; Stokols et al, 2005). This is not to say that some researchers did not embrace the expertise and perspectives of colleagues outside their own discipline, but the rewards and reinforcements of academic life demanded that individual research excellence prevail in a university environment. While the reward system in universities remains, to a large extent, focused on individual research accomplishment, there are signs that the future of health research is interdisciplinary. One important question needs to be answered: "What will be accomplished by …[a] group working together that they would not be able to accomplish as individuals?" (Marts, 2002) There is increasing evidence that working collaboratively in many cases improves research outcomes as "…each new generation of health care providers discovers anew the potential that exists in combining the complementary skills, knowledge, and approaches of the various disciplines" (Long, 2001 p. 279; Stokols et al, 2005). On the other hand, it is clear that the disciplines must be strong to bring their methodologies, experience, expertise, and energy to an interdisciplinary effort.

This chapter first explores definitions of interdisciplinary research, including common terminology, and briefly describes some aspects of the historical context of inter-disciplinary research. Given the importance of common language in interdisciplinary initiatives, be they related to research or practice, common themes and language are identified. Translational research, or knowledge translation, is currently receiving high priority from funders and government agencies, and is described in relation to interdisciplinary research. The chapter presents a working definition of interdisciplinary research for the purposes of this document and summarizes the major themes that characterize interdisciplinary health research.

Definitions from the health sciences literature

There are several terms used in the health sciences and interdisciplinary publications that relate to interdisciplinary research and which are, often erroneously, used interchangeably, including *interdisciplinary*, *multidisciplinary*, *interprofessional*, *cross-disciplinary* and *transdisciplinary*. Marts (2002) refers to the Institute of Medicine (IOM) report entitled *Bridging Disciplines in the Brain, Behavioural and Clinical Sciences* (Pellar, 2000) when describing *interdisciplinary* research as "a cooperative effort by a team of investigators, each expert in the use of different methods and concepts, who have joined in an organized program to attack a challenging problem" (p.502). *Transdisciplinary* is referred to by the

OIM (in Marts, 2002) as "the development of a common conceptual framework that bridges the relevant disciplines and that can serve as the basis for generating new research questions directly related to the defined problems" (p.503). Stokol et al (2005) use Rosenfield's (1992) work to justify the use of the term *transdisciplinary*. Rosenfield identifies the term as a process that involves shared concepts, as well as integration and extension of discipline-specific theories to address common research issues. Stokol et al contrast this with

> Interdisciplinary research "enables investigators across disciplines, including basic, translational and clinical scientists, to collaborate with a goal of bringing advances in scientific understanding of disease mechanisms and treatments to patients in need."
>
> --S. Spielberg, PI, New Hampshire Study of Lung Disease 2003

multidisciplinary research where independent or sequential research is said to take place focused on a common problem and *interdisciplinary* where greater sharing occurs but "…the participants remain anchored in their respective disciplinary perspectives and stop short of achieving the novel and integrative conceptual models that are the hallmark of *transdisciplinary* research" (p.204). They support Rosenfield's thesis that *transdisciplinary* research requires more extensive connections among researchers and therefore yields broader and more important research results.

The theme of a common goal is reiterated throughout the literature. Paul and Peterson (2001) define *multidisciplinary* models as those in which each individual does his or her work separately, despite sharing findings with other team members. Interprofessional

> Social Science perspectives are "fundamental to truly integrative, multilevel research strategies that consider the pathways to health operating at and between the social, cultural, individual, and biological levels."
>
> -- Bachrach, 2004

models differ in that work may be completed individually or collectively but members of the interprofessional [research] team interact frequently. Each member of the team is respected as an individual and each contributes equally to the ultimate goal. *Transdisciplinary* [research] teams involve role exchange and blurred responsibilities, and is not viewed as a functional model for research by these authors.

It is clear that the concept of collaboration in research in gaining ground. Fitzpatrick (2002) suggests that there are two types of collaboration: one involves consideration of a research question from several perspectives among a range of disciplines, merging ideas and using the best from the different perspectives to consider the research question. A second form

> The purpose of interdisciplinary research "…is to develop more comprehensive knowledge that offers a better understanding of the research problem than any one discipline could develop alone."
>
> --Kahn quoted in Merwin, 1993

of collaboration involves the formulation of a research question from a discipline perspective and the creation of an interdisciplinary research team to address the question and analysis (Fitzpatrick, 2002). Each type of collaboration, however, involves a range of disciplines working together, talking together, and seeking answers together based on a common goal or issue through the development of an interdisciplinary team (Nies et al, 2001).

The panel determined that for the purpose of this document, it would be discussing team rather than individual interdisciplinary efforts, acknowledging that individuals may make significant interdisciplinary contributions alone or as part of a team. Furthermore, the panel will explore team efforts where the problems and research approaches will be defined by the interdisciplinary team rather than by one discipline or individual.

History of interdisciplinary research

It can be said that interdisciplinary research in science is not new. In fact, it may be considered as old as scientific investigation itself. A problem-based approach has been the norm in scientific investigation since the time of Copernicus. In fact, the study of the development of disciplines themselves is the subject of an entire branch of history. In the health sciences, the development of medical specialties and subspecialties has been studied extensively, most notably through the work of Weisz (2003). This body of research traces the roots of disciplinary expansion and consolidation in the history of medical research and practice.

For the purposes of research however, the move toward reintegrating the medical disciplines around certain questions is much more recent. For instance, 15 years ago, the McArthur Foundation began to identify research questions that lent themselves to an interdisciplinary approach and then assembled a cadre of established researchers from a variety of disciplinary backgrounds who could come together to pool their expertise in order to answer a specific question (Marts, 2002). A network was established for each question and members of the networks meet regularly to discuss issues and plan collaborative approaches to the research at hand. Initially the Foundation tried to organize research themes around existing capacity but found that it was more successful to bring together researchers from different disciplines and institutions who could address the research question in the most effective way. Historically this was breaking new ground because it involved key researchers from diverse backgrounds and geographic locations to bring their expertise to bear on a specific research question.

Since that time, Canadian provinces are also turning to the model of research networks as the preferred model for the active participation of researchers from a number of disciplines in communication, partnership, joint research activity and analysis. Canadian examples…
- The way in which CIHR was structured in 2000
- The strategic initiatives and NET grant structures from CIHR
- MSFHR, FRSQ, Heritage…
- Networks of Centres of Excellence including AllerGen – the Allergy, Genes and Environment Network, CAN – the Canadian Arthritis Network, and SCN – the Stem Cell Network.

Despite emerging, some time ago, as a positive direction for health sciences research some time ago, interdisciplinary research is now gaining currency as a prominent approach. Models that appear to be successful clearly articulate the active engagement of researchers in communication, discussion, shared resources, collaborative research activities and collective analysis and dissemination of findings. The critical approach for success appears to involve joint ownership and acknowledgement of each person's valued contributions.

In passing, it can be noted that assessments by arms length groups such as the Institute of Medicine, Royal Society of UK, Royal College of Canada, and hopefully CAS and CAHS function in an interdisciplinary manner.

In spite of many limitations, Canada is evolving to be an excellent place to do interdisciplinary research in the health sciences. The new sources of funding support this type of research, the universal health care system allows long term follow-up and comparisons, and the Canadian "personality" embraces diversity, multiculturalism, and compromise. It is hoped that this assessment can strengthen the environment for interdisciplinary research in the health sciences in Canada.

Common themes and language issues

Common themes arise that characterise interdisciplinary research contexts. Many of these will be addressed in more detail in subsequent chapters. They include:
- The need to establish criteria for the appropriate review of applications for funding of …[interdisciplinary].research (Marts, 2002).
- Clarification of intellectual property rights, ownership of data, and credit for work (Marts, 2002).
- Finding critical numbers of investigators who are experienced in interdisciplinary research and who truly understand what it means (Marts, 2002).
- The need to address the appropriate timing of participation in interdisciplinary research in a research career. Will independent research success continue to be a precursor of interdisciplinary research or will collaborative approaches become a recognized focus for young researchers early in their careers (Marts, 2002)?
- Team building as a process (Nies et al, 2001).
- Communication among researchers as key to the success of interdisciplinary research initiatives (Stokol et al, 2005).

Translational research

Increasingly, scientists and clinicians recognize the need to bring discovery directly from the bench to practical applications in patients. This process is frequently referred to as 'translational research, what the Association of Professors of Medicine (APM) defined as "…the application of basic scientific discoveries into clinically germane findings, and simultaneously, the generation of scientific questions based on clinical observations" (Rutgi, 2004). This definition stops short, however, of linking basic science and clinical research into changes in practice that positively influence health outcomes. Often translational research appears to link promising technologies to randomized controlled trials and, although rigorous basic science methods applied to clinically urgent problems are deemed to be part of a translational process, there is little indication of the manner in which findings are translated for clinical professionals and possibly more interest in future areas of research indicated through the research findings (Crist, Shafer, Walsh, 2004).

An additional perspective on translation includes seeking the most effective way of disseminating new knowledge. If the target audience is health care practitioners, the message must relate to evidence-informed practice and specific practitioner practices. If the audience is the consumer, as in cases of translational knowledge affecting health practices

in a community, consumer involvement in planning dissemination strategies may be required (Marts, 2002). The interdisciplinary research team must identify the key audiences for knowledge translation and agree upon the most pragmatic and effective approach. Yet, one of the challenges of interdisciplinary research is determining where the work will be published or presented in order to recognize the contributions of each of the researchers so that their respective institutions and disciplines can acknowledge their accomplishments.

Links between interdisciplinary and translational research

Nadler (2002) suggests that translational research revolves around groups or teams of researchers and not individuals. His concept of a "translational team" captures the members of such a team in such a way that the interdisciplinary context is clear. Crist, Shafer and Walsh (2004) suggest that interdisciplinary or team approaches to translational research can be influenced by organizational support (tangible and intangible) for interdisciplinary work and by "…responsive platform[s] for translational research, and maximiz[ation of] creative potential through interdisciplinary initiatives" (p. 432).

Although the most common concept of translational research is the dissemination of research findings to practitioners in a way that positively changes practice and, therefore, health outcomes, Marts (2002) suggests that translation also applies within interdisciplinary research networks or projects. Interdisciplinary research leaders, for example, "…must be able to translate research approaches and models from one discipline to another" (p.503).

Principles underlying the IDHR approach
- Interdisciplinary research is conducted using a team approach and therefore requires the training of researchers in effective team functioning (Nies et al, 2001).
- Issues such as interdisciplinary and personal communication, philosophical models, and boundaries must be addressed early in the process (Hinojosa et al, 2001).
- A solid conceptualization of the research problem must be combined with advanced and appropriate methods (Merwin, 1995).
- Trust must be developed within the research team. Team members must be willing to risk following the advice of another without the ability to fully evaluate it (Merwin, 1995).
- Recognition of the different "cultures' of different disciplines; clarification of professional goals of team members early on; building interpersonal relationships that promote open and clear communication; expecting to make compromises; and building on individual talents and interests (Merwin, 1995).

A problem-focused approach

> "We are not students of some subject matter, but students of problems. And problems may cut right across the borders of any subject matter or discipline."
>
> -- Karl Popper, 1963
> Quoted in *Facilitating Interdisciplinary Research,* National Academy of Science, 2005

While the participating 6 health disciplines each bring their own strengths, traditions, knowledge experience and expertise to health research questions, the shared heart of their work is the quest for better patient and population outcomes. This quest is precisely what leads to the generation of new research questions from within a strong disciplinary foundation at the site of clinical and community practice. All professionals should be encouraged to think about the questions that arise in their daily practice that would benefit from systematic and rigorous analysis through proper research design. But what is important is the research question itself, which should not be constrained by disciplinary boundaries.

For instance, a nurse-scientist's work on infant pain expression through routine screening procedures stands to make a significant contribution to the ways in which paediatricians identify and diagnose pain.[1] Paediatricians, rehabilitation professionals, nurses, and neuroscientists may then collaborate on an interdisciplinary project to help map and categorise pain expression in children. The point is not the 'turf' to which the problem belongs, but that the improvement of infant outcomes remains at the centre of the problem, which has been taken up by a researcher who is closest to the issue. This researcher might then wisely choose collaborators in disciplines that stand to make the most difference in furthering the research and expanding its eventual impact at the clinical or population level. This is but one example among many for which adopting a "problem and patient focused approach" to research is more beneficial than thinking strictly along disciplinary lines.

Types of problems that are best approached through IDHR

In some cases, adopting an interdisciplinary approach can generate whole new research questions that were not previously considered within the 'home' discipline. The case of animal-human interaction research provides an interesting example. In its early years, veterinary research focused almost exclusively on farm animals, however the trend to study companion animals has led to "veterinarians becoming increasingly aware of the importance of scientifically studying, documenting and understanding the bonds humans have with their animal companions" (Meadows, 2002, p.606). To undertake such research, veterinary researchers are collaborating with health researchers to investigate the "social,

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[1] See work by F. Warnock, School of Nursing, UBC and the BC Research Institute for Children's and Women's Health (http://www.nursing.ubc.ca/faculty/memberbio.asp?c=69.1013748054263&t=1)

emotional, and health" (p. 607) benefits of pets and their concomitant impacts on individuals, communities and societies.

More often, it is an existing problem confronted by researchers that leads them to consider an interdisciplinary approach as the most effective way to tackle it. Here we consider some recent Canadian health issues that lend themselves well to an interdisciplinary approach, in particular due to their breadth and complexity.

The legacy of SARS
Many of the public sector's health agencies, such as those concerned with food-borne zoonoses, have shown growing reliance on the knowledge base extant at publicly funded universities. In the particular area of food-borne zoonoses for example, there are collaborations that have been funded by CIHR that involve Public Health Agency of Canada (PHAC) researchers working together with researchers from several universities and hospital laboratories across the country. The PHAC was created as a result of an investigation of our handling of the recent outbreak of SARS. It will require considerable interdisciplinary research activity to properly address Canadian public health problems for at least two reasons: (1) the very scope of these multifaceted issues themselves that cross many disciplinary borders and (2) the research work needed to be done will have to be nation-wide, involving federal-provincial data co-ordination, jurisdictional issues and differences in policies and procedures, all important issues that will need to be addressed. One consequent issue is that there likely will need to be different nodes in the provinces and at universities as well, for conducting the research, operational bases for implementation of policies and procedures, and dissemination of information.

Chronic Disease
Four major chronic diseases (cardiovascular disease, cancers, chronic obstructive pulmonary disease, and diabetes) account for three-quarters of all deaths and are the major causes of premature death and hospitalization in Canada. It is estimated that chronic disease costs Canada the equivalent of 9% of its GDP annually and medical care costs for people with chronic disease account for 42% of total direct medical care expenditures or $39 billion a year. The indirect costs of chronic illness due to productivity losses account for over 65% of total indirect costs or $54.4 billion annually to Canadian taxpayers (The Chronic Disease Prevention Alliance of Canada, 2004, Academic Case, HSALC). Chronic disease is most common in persons over 65 years of age. In Canada the proportion of citizens over 65 years of age is expected to increase from 12% in 2000 to 18% by 2020 (Health Policy Research Bulletin, Health Canada, May 2004).

Through competent single discipline practice, each individual health discipline has identified this "big, complex" health challenge for Canadians. It has been recognized that success in the management of chronic disease requires utilization of interdisciplinary health scholarship (Health Council of Canada, 2005). Policy makers, physicians, nurses, pharmacists, rehabilitation professionals and other health service professionals have identified the need to work collaboratively to provide the scholarship to support appropriate chronic health services where and when they are required by clients. Research, education, and service partnership across disciplines and sectors (regional health authorities, universities, and funding bodies) will stimulate research initiatives directed at the

challenges associated with the impact of chronic disease: appropriate education, recruitment, and retention of health service professionals; patient safety; use of information technology; integration of service across the levels of prevention and across the geographic and cultural diversity of Canada; effective implementation of primary health care; health promotion; and the need to establish consistent and continuing performance measurement with accompanying policy directed resource allocation.

Child Poverty

Although the aggregated practice of the traditional health care professionals through the health care system accounts for 25% of the health of the Canadians, it is estimated that the socio-economic environment has the majority of influence (50%) on national health (CIAR, 1997). Despite growth in the Canadian economy during the latter half of the 1990s, which resulted in an increase in jobs and a decline in unemployment rates,[13] the incidence of low income among Canadian families remains essentially unchanged.[14;15] Further, in Canada, having work does not preclude living in poverty. For instance, in two-parent Canadian families with one earner, 26% have low incomes. In female-headed single-parent families where the mother is employed, 43% live on low incomes[16]. Low-income families suffer severe health consequences. The Canadian infant mortality rate is two-thirds higher in low-income neighbourhoods than in the highest income neighbourhoods.[19] Poor Canadian children are more likely than their peers to suffer from ill health, to have lower levels of educational attainment, and to experience major behavioural problems.[8;9;20-25] Living with a low income compromises parental physical and mental health, influences adaptation to parenting, threatens family resilience, and jeopardizes family-community relations.[26;27] The health of low-income parents influences their ability to attain and maintain employment.

The restraint in public expenditure and resulting movement away from universal services,[10] which began in the 1990s, continues to affect those living in poverty the most. A consistent negative association exists between family socioeconomic status and engagement/retention rates of families in health, social, educational, leisure, and cultural activities.[6-9] Many of these services are experienced as markedly unhelpful by the vulnerable populations they are designed to serve. Barriers include: fragmentation; narrowness of mandate; power differentials created by provider expertise; and difficulty in access because of location, language, and hours of availability. This combination of family and service barriers results in reduced opportunities for effective, primary-level services and in increased use of secondary-level services (e.g., emergency room visits, emergency intervention, police involvement) by low-income families, with the obvious increase in costs.

Issues facing low-income families are rooted in an array of social, economic, and political conditions that extend far beyond the control of any one health or social service sector. Solutions will be more effective when they are developed and implemented by interdisciplinary intersectoral partnerships comprising health science scholars, government agencies, non-governmental organizations, and communities. The interdisciplinary solutions depend on the strength of the individual disciplines as they come together. It is the disciplinary knowledge that allows the difficult questions raised to be addressed in a more comprehensive way. However, not only is strong disciplinary knowledge essential, but expanding the idea of who should be involved in improving the health of Canadians is also essential.

With a better sense of the types of problems best approached from an interdisciplinary perspective, the following two chapters consider the application of the approach in academia, government, and industry.

IDHR: Not a panacea

While it is true that many complex health research issues are best approached through collaborative work across disciplines, it should be noted that IDHR is not a panacea with which to tackle *all* health research problems. The time and commitment required for truly engaged IDHR – through consensus and team building, achieving the right mix of methodologies, and analysing according to a broad spectrum of aims – is simply not a realistic nor desired option in some cases.

Indeed, the promise and benefits of IDHR do not mean that it is necessary or desirable to replace the experience and expertise of researchers with a solid disciplinary grounding. On the contrary, it is this disciplinary foundation that anchors an interdisciplinary endeavour. Without it, the rigour of the research methodology and data collected may be diluted or compromised.

Finally, there is nothing that can replace the valuable knowledge generated through pure, basic research that is anchored in a particular discipline. It is on the foundation of this discipline-based research that more complex questions may then be framed, requiring an interdisciplinary approach.

> **Recommendation for Assessment:**
> *The following section details some of the main topics associated with IDHR in an academic environment – from training to research, promotion and rewards.*
> *The corresponding chapter **2.1** in the Framework for Assessment outline the questions flowing from the discussion presented here. The questions need to be set within a program of proposed research that seeks to evaluate the current state and future prospects of fostering IDHR in academic environments*

A key characteristic of interdisciplinary scholarship is the integration and synthesis of information or ideas, rather than the additive approach of multidisciplinary enterprises (Bines, 1992; NAP 27). By its very essence, interdisciplinary scholarship requires the deconstruction of knowledge and identity, which is then reconfigured into new forms of knowledge and action. The complexity of this intellectual activity requires a high degree of confidence in disciplinary knowledge and practice. Researchers working in the interdisciplinary realm must demonstrate the mobility to move between interdisciplinary and disciplinary scholarship. This ensures that they do not lose sight of the disciplinary strength they bring to their interdisciplinary work.

Solid foundation in 6 health disciplines

Historically, the need for specific health providers was established at the site of delivery of health service, in other words, training on-the-job (Ford, 1983). The practice requirements were dictated by the service needs of the facility and not by established standards. Eventually, on-the-job training programs became more formalized as education programs. Professions became institutionalized with accompanying national practice standards with licensure, certification and/or registration requirements. By the 1960's, a more or less complete transition to education outside of the service provision environments had occurred for the health professions (National Commission on Allied Health Education, 1980; Dufton, 1992). This was accompanied by a growing emphasis on disciplinary scholarship.

Case Study: Alberta Health Professionals Act

In Alberta, there are 30 regulated health professional categories, all legislated under the Health Professions Act (HPA). The HPA regulates all health professions, but allows for the unique clinical role that each profession plays in the health system. While the skills learned by each profession may have some overlap, each one has a unique set of skills. Certain tasks may be performed by a number of professions, but there is a comprehensive set of skills needed for different environments, which make certain professions ideal in certain situations. In addition, there are some activities, which are completely unique to a profession that makes them essential when delivering that particular function. It is the diversity of skills that makes each profession necessary and essential to the functioning of the health system as a whole. In different environments, depending on the needs of the population being served, different mixes of professionals may be most beneficial. These best practices are learned through experience and careful examination of both the skills needed and available through different professions.

Disciplinary scholarship is **evidence-based** and provides **best practice** (Haynes, 2002) in service and research approaches. In this way it provides the foundation of safe practice and serves the major role of protecting the public. The regulatory bodies for the disciplines are responsible for ensuring that those they register have the skills needed to practice in their chosen profession. Their accreditation procedures are outlined through their provincial health profession legislation. Accreditation assures the public that individuals have met a standard that is appropriate for their profession. Public confidence in the professions and those providing services is essential to their credibility.

However, overly protective regulation can hinder necessary intra-professional change and produces barriers to effective interdisciplinary *practice* in the first instance, not to mention interdisciplinary *research* (Health Council of Canada, 2005). Some provinces changed their provincial legislation to allow for more integration and interaction to occur between professionals (See Alberta Health Professions Act in textbox on preceding page).

Through competent practice within a single discipline, in an environment of *enlightened regulation*, the limits of each discipline are experienced. The result is evident in the identification of the "big complex" knowledge and practice issues of the day. In addition to health issue recognition, the provision of a secure body of disciplinary knowledge is the first step to integration and synthesis in interdisciplinary settings, both practice and research.

Broadly defining health science disciplines

A broad definition of health disciplines is required if the complex health challenges such as chronic disease and child poverty are to be addressed. In addition, Canadians have long recognized the importance of the prerequisites of health, such as education, income, food, social justice and equity (WHO, 1986) and the social determinants (Centre for Social Justice, 2003) for the health of individual citizens and populations. In the Kirby Report (Kirby, 2002) it is calculated that 75% of Canadian health is determined by physical, social, and economic environments. In order to address the impact of complex environments and determinants, other professions and disciplines must be included in interdisciplinary health science research. Clinical psychologists, social workers, educators, health economists, engineers, lawyers, chaplains, and child development specialists can and need to be involved to enhance the overall understanding of health in a broader context.

Government has taken a keen interest in academic interdisciplinary research, particularly as it relates to policy. Since policy setting requires input from many disciplines, it is imperative that government support both the disciplines and their interaction to ensure the best decisions will be made. There is a need to differentiate policy *research*, which informs decision makers, and policy *setting*. Interdisciplinary research is critical to understanding how to make policy decisions, but government is still positioned as the decision maker. The idea that the knowledge generated through interdisciplinary research will reach decision makers is a significant goal. As a bi-directional process, this knowledge translation also feeds back to the disciplines to strengthen their research programmes and practice.

Role of interdisciplinary health science education

Until health science students can articulate the 'culture', values and clear understanding of their discipline specific role, true interdisciplinary collaboration cannot occur (Parsell and Bligh, 1998; Clark, 1994; Hall and Weaver, 2001). The goal with interdisciplinary education then, is to foster understanding and respect for differences and similarities among the disciplines. It is not to create professionals who think identically. Respect for and understanding of other health disciplines – the prerequisites of collaborative research and practice – can begin even before health science students possess strong disciplinary knowledge (BC College of Health Disciples is a good example).

Case study: The University of Alberta Health Sciences Council
The Council is a matrix model (see Figure 1) where scholars move freely among strong disciplinary faculties that are bridged and linked by interdisciplinary initiatives (research projects, centres, offices, programs, curricula, and institutes "without walls") and organized around problems rather than disciplines.

The goals of the Health Sciences Council are to:
- Identify, develop, sustain, and review inter-professional and interdisciplinary initiatives that will advance health science scholarship.
- Facilitate synergies between the strong faculties, supported by the larger university community, Capital Health, and Alberta public systems.
- Scan, identify, broker, sustain, and evaluate interdisciplinary health science research and practice initiatives.

Direction for the Health Sciences Council is provided by:
- Deans of the six health science Faculties,
- The Associate Vice President (Research)
- Representatives from the local health authority, Capital Health.

A task force was struck by the council in 2003 to examine issues related to interdisciplinary research, education and service, and to make recommendations on how to reduce barriers to interdisciplinary scholarship (HSC, 2003). An action plan with both long term and short-term solutions was outlined and implemented. Issues included:
- Promotion, recruitment, capacity building, demands of split appointments,
- Alignment of disciplinary curricula for inter-professionals
- Sharing of indirect costs and infrastructure costs to faculties,
- Administrative processes like research services from faculties,
- Campus awareness of role of the Health Sciences Council.

The Health Sciences Council is a mechanism for change management where the boundaries defined by the disciplines are crossed to allow interdisciplinary activity to occur. While it is apparent that there will be inherent competition for funding between interdisciplinary and disciplinary research, there is an understanding that success in either area adds strength to both and, in fact, depends on it.

Common learning is one approach to fostering collaboration among the health disciplines. Common learning provides students from different disciplines with the opportunity to learn similar content in a shared learning environment (Barr, 1994). Specific discipline related information is then taught outside of the common learning environment. In learning how to work together within a specific context or to manage a specific condition, a comparative learning approach can be adopted. This allows for a more complex interaction among the health science students resulting in an integrated patient-centred management plan, not to mention keeping the patient at the centre of any potential research.

In summary, key to identifying the complex health challenges that can be addressed through an interdisciplinary approach, and foundational to the synergy of interdisciplinary scholarship, is the discipline specific scholarship within the health sciences. It is the amalgamation of disciplinary knowledge that adds the value. This is tempered by the need for enlightened regulation of the health professions to ensure interdisciplinary team building is possible.

Post secondary institutions are not traditionally configured to support interdisciplinary scholarship (Clark, 2004). The pressures inherent in complex health science questions (see chapter 1.3) and the application of strategically directed resources may initiate a change within an institution towards greater collaboration between the health science disciplines. However, achieving sustainable long-term interdisciplinary programs of research and education is more challenging. Support at all levels of the university is required. The Health Sciences Council, developed at the University of Alberta (see textbox, this chapter) is one approach to developing sustainable interdisciplinary scholarship that has been successful.
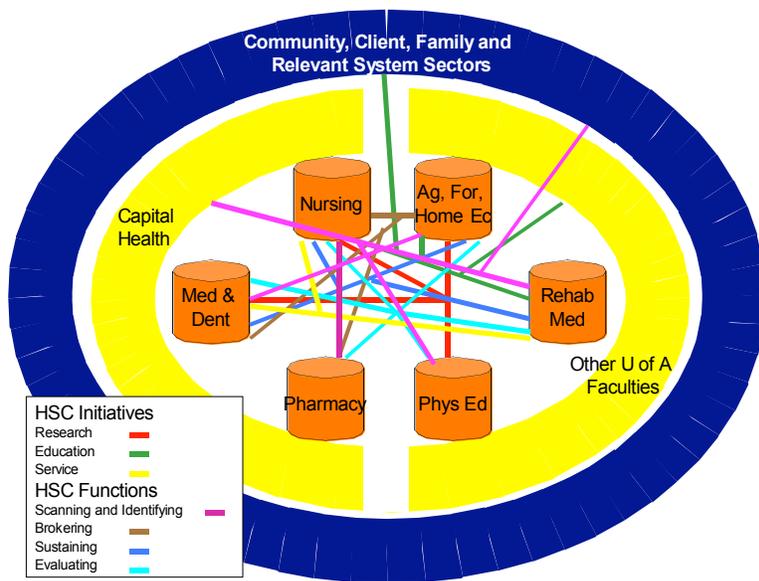
Figure 1:
University of Alberta
Health Sciences Model

Interdisciplinary academic research

Universities have been the traditional home of knowledge creation and have done so within the disciplinary boundaries of departments. With the emergence of new information technologies and the "knowledge economy", other venues within government and the private sector have become increasingly involved in knowledge creation as well. The complexities of today's questions and pressing societal problems have created fertile ground for the emergence of interdisciplinary research. For organizations not steeped in a disciplinary tradition of knowledge creation, the development of interdisciplinary research has proceeded rapidly. Within the Academy however, interdisciplinary research although much heralded in University strategic plans (and despite some progress) continues to face significant institutional challenges. It may even be argued that these challenges are even more complicated within the Health Sciences.

Structurally, the challenges are based in numerous historical, cultural and organizational features of the University as an institution. Historically, the University as a centre for knowledge creation organized itself physically and conceptually around specific knowledge content areas such as the sciences and humanities. Consequently, the medical sciences departments of biochemistry and anatomy are housed in one building often on one end of a

campus, while ethicists from philosophy or social scientists such as psychologists or sociologists are in yet other distinct locations. Even university libraries are arranged to support distinct disciplinary identities. Within each separate and even isolated location a distinctive culture flourishes, steeped in its own symbolic generalizations, models, and exemplars (Giacomini, 2004). These three properties characterize the core cognitive operations of the discipline; and hence provide the heuristic for its research endeavours and knowledge creation.

These foundational elements allow for cohesion within the discipline via a common language, the identification of the important research questions for the discipline and the establishment of standards for evidence (Kuhn, 1969). In this way, the identity of the discipline is formed and maintained. Other academic organizational structures reinforce this identity through control of resource allocation (e.g., faculty positions, budgets, and space allocation) and curricula and educational requirements for degrees. Related institutions that affect disciplinary identity within the academy are the granting agencies that set the national research agenda and fund it, available venues for publishing research results where editorial boards consist of disciplinary experts and research societies. As Giacomini (2004) states, "Disciplinary cultures shape members' identities, relationships and even the knowledge that is created by determining what counts as work and even *whose* work counts."

In the Health Sciences, the identity of academic health science disciplines is further complicated by often-dual identities created by their roles as educators of professional practitioners. Health Science departments in Universities often serve two masters: 1) the University, its academic standards and cultural values, and 2) the professional colleges and organizations that accredit these programs to educated health care practitioners according to their standards and values. While we hope that the two coincide, they are not always complementary and in fact may be competing. So, while the organizational structures inherent in a University may create challenges for interdisciplinarity, so may the protection of 'scopes of practice' or accreditation dictated curriculum requirements for the education of students in the Health Sciences.

Protection of professional scopes of practice may be confused with knowledge based disciplinary boundaries. Attempts to protect knowledge content areas in the same way as professionals protect scopes of practice would inhibit interdisciplinary efforts. The role hierarchy that exists for health science professionals in the practice domain (e.g., the physician as the leader of a team, with other "allied" health professionals as participants) does not transfer well to the academic research domain interdisciplinary settings and in fact would serve to inhibit formation of common trust and respect so essential to successful interdisciplinary work. Further, while Universities may try to promote interdisciplinary study and research in Health Sciences, the cultures of professional bodies may legislate against it.

Conversely, if professional organizations attempt to support calls for interprofessional training for professional students, University structures affecting space, geographical location, timetable scheduling, curriculum regulations or even faculty workload agreements may create barriers. Consequently, the Health Science disciplines have a double challenge in creating a fertile environment for interdisciplinary research in the academic setting.

Interdisciplinary academic training

Interprofessional Education: The notion of interprofessional education is not new. Indeed, over 25 years ago the World Health Organization identified interprofessional education as an important component of primary health care (WHO, 1978). More recently, interprofessional education has received renewed attention in Canada with the Romanow report on the Future of Health Care in Canada (2002) suggesting that interprofessional education and collaborative practice are critical for effective health care delivery. Health Canada has also endorsed the importance of interprofessional education and collaboration through its commitment of $19.3 million to fund new projects in 2005.

Support for interprofessional education is based on the rationale that students who learn together will gain a better understanding and appreciation of each other's roles in health care. The assumption is that this, in turn, will lead to improved collaboration following entry to practice, and subsequently to improved patient outcomes.

Whether this rationale can be extended to interdisciplinary *research* initiatives has yet to be examined in the literature. However, it is logical to infer that students from different disciplines who study together will gain a better understanding of each other's research traditions and language, thus resulting in improved research collaborations in the future.

Given the explosion of literature in the area of interprofessional education and the recent commitment to these initiatives, the question of whether the literature can inform future initiatives/directions for interdisciplinary research is an important one. Unfortunately, the effectiveness of interprofessional education remains largely unexamined. For example, a systematic review by Cooper et al (2001) found that interprofessional learning resulted in positive changes in knowledge, skills, attitudes and beliefs of the students involved, however there were no effects on professional practice behaviour and no information about collaborative research. In another review Freeth et al (2002) concluded that some evidence exists to support improved learner attitudes, knowledge and skills following interprofessional education however they emphasized the need for further research using rigorous longitudinal designs. Although emerging research suggests that interprofessional education is likely to improve health professionals' skills, the lack of strong evidence to support changes in practice following graduation may be a deterrent to implementation of innovative initiatives.

It is recognized that only a small percentage of health professional students will pursue research careers. However, given that interprofessional education is likely to promote skills important in communication and collaboration and that these skills are essential for interdisciplinary and translational research, it seems an important direction to reinforce.

Clinician-scientists and post-doctoral training: Clinician-scientists are "researchers who have a health science professional degree along with research training as evidenced by a Master's or Doctoral degree or equivalent, and who perform health science research of any type as a core professional activity" (Phillipson and Silverman 2002, pg 27). Clinician-scientists face unique challenges such as poor bridges between training and faculty positions and insufficient mentoring (Phillipson and Silverman, 2002).

The time taken to complete training to be a clinician scientist may be a deterrent for many. Health professional training ranges from 4 to 6 years; further master's, doctoral and post-doctoral training can add a minimum of 6 – 8 years. If interdisciplinary educational initiatives are viewed as contributing to additional years in training they will not be perceived favourably. Studentship and post-doctoral training awards that reward interdisciplinary training will be essential to promote this approach.

Other perspectives: There are currently many practicing health sciences researchers who have not been trained with the knowledge and skills to collaborate with other disciplines. While these skills are described in the literature as an important core competency for interdisciplinary research, there are no formal continuing professional education programs aimed at developing them. Given that interdisciplinary research collaborations will extend beyond academia to include government and industry it will also be important to include these sectors in continuing education initiatives. Nevertheless, there should always be room for the individual research who works and functions best alone or in isolation.

Approaches to training and learning

Teaching and learning methods can be used to strategically reinforce interdisciplinary education and research. Pedagogical methods, the teaching faculty, and the design of the degree are important elements to consider.

The extent to which pedagogical approaches reinforce interdisciplinary interaction and problem solving needs to be examined across the spectrum of education from undergraduate to post graduate. Problem or case based methodologies promote models of problem solving, which integrate the disciplines and facilitate broad based discussions among students. "Problem-driven questions" (Committee on Facilitating Interdisciplinary Research, 2005) also have been advocated as a means to promote interdisciplinary education in undergraduate students.

One appealing aspect of small group problem-based learning is the emphasis on group process and interaction within the group. Skills in group process, communication and collaboration are fundamental to a well functioning interdisciplinary research team. Educational models that require interaction between learners and promote development of these skills will provide students with collaborative skills essential in both practice and research settings.

Faculty are prominent role models for students. Students need to be exposed to faculty members whose research foci are interdisciplinary. In undergraduate and professional programs this may be through team teaching with exposure to teachers from different disciplines. A number of potential models have been proposed in postgraduate education including dual or multiple mentors from different disciplines (Committee on Facilitating Interdisciplinary Research, 2005).

A significant concern among many academics is determining the extent to which students must master a specific discipline or be proficient in their own profession before engaging in interdisciplinary education and research. Interdisciplinary activities may be perceived as

"nice to know" rather than essential curriculum. In the health professions there is ongoing and competing demand for curricular content. This may result in interdisciplinary or interprofessional activities being perceived as a "luxury" in a crowded curriculum with little time devoted to these initiatives. McCarthy (2004) acknowledges that most in academia and industry appreciate the value of individuals with interdisciplinary training but do not know at what stage interdisciplinary training should start. McCarthy acknowledges that there are limits to the amount of content that can be added to any curriculum without compromising the core elements of training. He suggests that a limited number of specialized courses would provide students with "a taste of power and excitement of interdisciplinary approaches" (pg 936).

Related to the development of skills necessary for effective interdisciplinary collaborations is the increased emphasis on teaching professionalism to health professionals pre-licensure. Although there is wide variation in the definition of professionalism and professional behaviour, typically these are thought to encompass skills essential to effective collaboration including communication and group skills, demonstration of respect for others and sensitive practice (e.g., Klein et al, 2003). There have been concerns that the predominant structures and processes in education have resulted in an increased need for professionalism. Admission processes, with an historical emphasis on selection of students based solely on academic grades, and curricula that place the highest value on scientific knowledge are thought to produce students who lack a broad base of knowledge and skills (Wear and Castellani, 2000).

Recommendations: Academic Training
- Models of interprofessional education be promoted and examined as a way to enhance communication and sharing of research cultures and perspectives across professions.
- Training and education should incorporate pedagogical strategies that promote interdisciplinary problem-solving and development of group process and collaboration skills.
- Educational models need to take advantage of the fact that faculty are powerful role models and mentors by incorporating innovative strategies such as team teaching and dual mentors.
- There is a need to develop unique models of education for clinician scientists that enables timely completion of their training.
- Meaningful studentship and post-doctoral support is required to support training in interdisciplinary research.
- Universities should develop short-term courses and practice for doctorally-prepared researchers who wish to develop IDHR skills.
- Research funding agencies and universities should implement workshops and other educational sessions to teach about research methodologies and approaches to researchers that typically do not incorporate them in their discipline-specific work.

Other barriers to developing these skills pre-licensure include difficulties in evaluation of more "qualitative" knowledge and skills. Faculty are important role models in this area and it has been argued that poor role modelling and lack of reinforcement of positive behaviour leads to unprofessional behaviour, hierarchical relationships and substandard interpersonal relations. The increased attention on professionalism aims to produce professionals who are better able to collaborate in interdisciplinary clinical and research teams and thus is an important direction to reinforce.

Design of undergraduate degrees may reinforce or hinder interdisciplinary education. As noted by Ares Jr (2004) the focus on a "major" in undergraduate education "begins the process of disciplinary allegiance" (pg. 1171). He suggests that a shift occur so that declaring a major can be viewed as exploring an area of interest rather than as a lifelong commitment to a specific discipline. In recent years the number of interdisciplinary undergraduate programs has increased in Canada.

Approaches to promotion and rewards

Individuals undertaking interdisciplinary research can be disadvantaged at the point of promotion into their first faculty appointment. The time taken to publish is longer and it is more difficult for hiring committees to evaluate input into multi-authored papers. This is exacerbated by the practice of Universities positioning major interdisciplinary research centres and institutes in Faculties of Graduate Studies. Individual researchers must find a Departmental sponsor, if that Department is not going to benefit from either their training or research activity, there is little incentive to hire them.

Tenure is also a consideration for would-be interdisciplinary researchers. Traditional metrics for tenure require individuals to hold significant peer-reviewed grant funding in their name, to have published in relevant journals, to have contributed to training and to have a national reputation in a field. For those involved in interdisciplinary research, the challenge is to demonstrate to reviewers the contribution to multi-investigator research grants and multi-authored publications.

Recommendations: Promotion and Rewards

- Letter from post-doctoral supervisor should clearly identify disciplinary strengths of an individual and the benefits to a Department then stress the benefit to the Department and University with respect to complementarity with relevant interdisciplinary programme.
- Institutions should provide incentives to hire faculty who are team players.
- Candidate for initial appointment or promotion should provide a clear statement of their contribution to all publications/presentations, including statements from co-PIs on peer reviewed grants that document the input in question.
- Make merit a yearly award that is not recurring in the base salary, provide clear guidelines indicating that interdisciplinary research will receive priority for these awards.
- Create specific prizes and grants to reward those working in interdisciplinary research, e.g. UBC has the Peter Wall Institute for Advanced Studies that funds interdisciplinary workshops and grants.
- Universities should provide sufficient funding and space for IDHR, and ensure that faculty engaged in IDHR have workload assignments that take into account the demands of IDHR

1.5   IDHR in Government and Industry

Recommendation for Assessment:
*The following section details some of the main topics associated with the role of IDHR in Industry – from the motivation, to the structure of timelines and rewards in industry. The corresponding chapter **2.3 and 2.4** in the Framework for Assessment outlines the questions flowing from the discussion presented here. The questions are then set within a program of proposed research that seeks to determine what lessons can be drawn from and industrial environment to foster IDHR in Canada.*

Although typically IDHR has been considered in the realm of the university, government and industry have well-established records in IDHR and have much to offer in terms of insights about the benefits, challenges and complexity of the practice. In this chapter, we describe the various types of collaborations that university-based researchers can establish with industry or government. Industry in this context refers to people or companies engaged in a particular kind of commercial enterprise, such as the pharmaceutical industry. Government refers to governmental departments or bodies at the municipal, provincial or federal level. In addition, we explore the unique context and culture of industry and government and the challenges these present to IDHR.

Over the past couple of decades, governments and industry have taken significant steps towards closer collaboration with universities, including in areas considered interdisciplinary in nature. In part, this increased collaboration has arisen through the evolving attitude on the parts of the public and politicians that universities should be more accountable for their expenditures of public funding. In addition, governments and industry increasingly are seeing real-world value in the intellectual capital produced in universities. The private and public sectors have realized that this value can be harnessed to further their objectives, the nature of which often fall outside the disciplinary boundaries established in the Academy, which can seem quite artificial in "real world" contexts.

Increasingly, as CIHR grows into its new mandate of support for research for "bench-to-bedside" provision of health knowledge, governments and business are being drawn into partnership arrangements through CIHR's programmes and policies. These partnerships were unheard of in the CIHR's predecessor, the Medical Research Council, and testify to CIHR's foresight and innovation. Indeed, overlap is inevitable between CIHR's academic projects and areas of interest and activity of researchers in ministries such as Health Canada, Indian and Northern Affairs, Industry Canada, and a multitude of other science-based governmental departments and agencies. The challenge for the future will be to minimize redundancies and harmonise areas of responsibility.

Differing values, motives, goals and needs

More than their university counterparts, researchers based in governments and industry are bound by the concept of return on investment. Public and private sector researchers are compelled to observe strict milestones and work to dictated timelines. In addition, the goal-oriented research of the sectors requires clear tasks and expected outcomes. For instance, an industrial research team may be tasked to discover a drug having a particular property, to improve the efficiencies of a process, or to deliver a product to a customer or face contractual penalties.

By contrast, university researchers respond to different criteria not often faced in industry or government. Examples include the inclusion of student training in research projects, or the involvement in debates or participation in academic discussions that privilege creative exchange over achieving a defined outcome. These goals are espoused less frequently or more tacitly by industry and government.

Researchers in any setting (university, government, or industry) are opportunistic in their behaviour. Major differences arise in the culture of the group depending on the source and nature of the opportunities for research support that exist. In industry and government, most research is supported from within the organization, whereas in universities, almost all of the funding is derived from outside the organization – either with federal or provincial granting bodies, government ministries, industry, or non-for-profit agencies. The source of the funding has a marked influence on the behaviour of researchers and the research culture that develops in the organization.

Although industry and government share some aspects of this culture, their values and interests are different and it is convenient to consider them separately for the most part. There are, however, many co-operative research activities that involve both industry and government and several that include universities as well. In these cases the interests of the various groups are usually constrained by specific requirements of a funding organization but the cultural differences are likely to persist. Interestingly, as the frequency and scope of collaborations among industry, government and universities increase we are seeing a merging of cultures in interdisciplinary research in all areas, including the health sciences.

This said, there is a paucity of literature on the values, interests and culture that influence interdisciplinary research in industry and government in Canada and other countries. It is therefore necessary to rely on the experience of individuals (including the authors), policy and program statements, to assess IDHR in the public and private sectors. Assessment in this area is outlined in Part 2 of this report. Some of the main considerations for this enquiry are presented below.

Industry: It must be remembered that the largest sums of money are spent by a small number of large multi-national companies, whose policies and directions are frequently set outside Canada. The values, interests and cultures of these organizations tend to be universal. Frequent mergers of several of these companies have created massive international organizations with a wide range of expertise and facilities. Most companies, however, are small organizations that are usually Canadian and are often dependent on support from government and universities. The values and culture of these smaller companies are often greatly affected by the individuals who lead them and by the financial constraints under which they operate. Nonetheless, both types of organization have a need to make a profit from goods and/or services that they deliver to the health care system.

Government: Unlike industry, government has a mandate to meet the needs of the public rather than just the goals of shareholders. Canada's Science and Technology (S & T) Partnerships identify four roles for government in S & T: funder, facilitator, performer and regulator. Because of these four roles, government departments are often cautious about the possibilities of perceived or real conflicts of interests between performance and application of research, and regulation. In other cases it may be difficult for a government department to obtain information or samples from individuals or private organizations that fear potential repercussions arising from a regulatory role related to findings by the government department during the conduct of the research.

In government, the research motivations and areas are different from those in industry. Researchers interested must justify that their topic is a significant public concern. In some

cases, the research itself is politically motivated in response to local pressures. Like industry, government laboratories tend not to be organized on a discipline basis and are well poised to undertake interdisciplinary research by themselves or in collaboration with universities and/or industry. The values of interdisciplinary research and of teamwork are emphasized and researchers often work as teams designed to tackle complex problems. There is an emphasis on short-term objectives but the expected result is not always a product or service. There are some projects in which the goal directly addresses a concern in the health care system, but there are others in which the goal is to provide information that will eventually contribute to policy development.

Thus, government is not as product or service oriented as industry in their motivation for research. In this respect research in government laboratories is more akin to what is done in universities. Indeed, government-university collaborations are quite common. Government-industry collaborations also occur but at a lower frequency. Collaborations among government, university and industry teams appear to be increasing.

Government based research may be slowed by administrative structures that can be cumbersome, even preventing rapid response to urgent needs. The budgeting or hiring processes in some departments of government may be subject to unexpected changes in favour of other non-research priorities of government, resulting in reduced research capacity. However, all government departments do not have the same culture, which seems to be affected by the traditions that have developed over time and by the individuals who lead divisions or departments.

Training: Both government and industry laboratories can provide excellent environments for training, especially for postdoctoral fellows. Students who have received their PhD in a specific discipline in a university but have an interest in gaining experience in a strongly interdisciplinary environment may find that industry and government laboratories are excellent locations for this. Government laboratories such as the NRC Steacie Institute for Molecular Sciences have developed world class expertise in certain areas of interdisciplinary research that underpin developments in health sciences. Areas of focus in this Institute are nanoscience, bioscience, and optical science. Such laboratories are magnets that attract researchers from a wide range of areas in interdisciplinary health research. However, Canada has not yet followed the lead of other countries, such as Australia, which has created industry research scholarships in health related research provided by federal research granting agencies (Turpin, D., Garrett-Jones et al., 1999).

Time-limits and intrinsic evolving nature of research

The vast majority of research performed today in Canada in industry and government is team-based. If this research is interdisciplinary in nature, the team approach will likely bring together individuals who vary in their core competencies and specializations. It is hardly surprising therefore that it will take longer for the team to see results and elicit specific outcomes. In governmental circles, this time constraint may pose a very serious barrier to the effective conduct of the proposed interdisciplinary work, as the public sector works on a yearly cycle of funding and projects often need to be completed and funding accounts reconciled within clearly circumscribed temporal windows. By contrast, research performed by industry usually will have no such constraints and may well be better suited

to support interdisciplinary projects in this respect. Business is highly product-oriented rather than ruled by the fiscal year. In addition, business has the capacity of moving very fast when the outcome is definable and the corporation is strongly motivated to move on a given product.

Both the time issue and the inherent motivations behind government and industrial research seem to overlook a point that is essential to academic research. That is: research is essentially knowledge generation systematically pursued, and science advances best when solutions to earlier questions lead to additional questions. Indeed, research is an inherently iterative and evolutionary process. History has shown us repeatedly that the most useful knowledge comes from answers to questions that were not specifically directed toward eventual outcomes. University research subscribes to this ethic most easily, while industry and especially the public sector place a lesser value on such curiosity. This fundamentally different philosophy will have an impact on the way in which interdisciplinary research can proceed in each of the three sectors.

Types of interdisciplinary relationships in industry and government

IDHR relationships in industry and government may take a number of forms. These relationships can be classified in the following ways:
- *Phantom* (the research was arranged by individuals without knowledge or support by the institution or the researcher agrees to place his/her name on the proposal without intending to be involved in the research);
- *Proposal* (the partner/researcher provides a letter of support for the research proposal and may provide some feedback about it but does not participate in the research);
- *Facilitator/sponsor* (the partner supports the research by providing staff or financial support or access to data or specialized equipment);
- *Dissemination* (the researcher/partner is mostly involved in the dissemination of the research findings);
- *Active* (researchers are involved in the research but their least contribution is in data collection);
- *Other* (researchers are involved in all aspects of the research, including data collection, analysis and publication) (Turpin, D., Garrett-Jones, Speak, Grigg, & Johnston, 1999).

In an Australian survey of industry-university research, most respondents (academics = 56%; industry researchers = 75%) indicated that they were involved in all aspects of the research process from planning to dissemination (Turpin, D., Garrett-Jones et al., 1999). Partners in such research are generally universities and associated institutions (e.g., research centres), the private sector (including industry-sponsored research centres), and government institutions (including departments, agencies etc). However, IDHR in industry and government also may involve NGOs, such as aboriginal organizations and disease-related interest groups; governmental agencies at local, provincial and national levels; community organizations; foreign governments; and international organizations.

Governmental and industrial research relationships are also differentiated according to:
- *Intradepartmental* (two or more departments contribute funds);

- *Interdepartmental* (two or more departments share funds from a single source);
- *External* (one or more institutions/departments work with external partners, such as universities, using pooled resources);
- *Targeted* (one of more institutions/departments works with external partners with dedicated funding from government or industry);
- *Delegated* (one department/institution funds other institutions to conduct research of mutual interest);
- *University linkages* (a department/institution enters into an agreement with a university or university researcher to provide research knowledge, expertise or equipment);
- *Networking* (a standing arrangement between researchers representing one of several institutions and various stakeholders, such as the Networks of Centres of Excellence across Canada) (Sussex Circle Inc., 2003).

In Canada, there are a growing number of government or industry-supported mechanisms that encourage university partnerships in IDHR. The National Research Council for example, has sponsored a Canada Research chair position at the University of Toronto, while a number of pharmaceutical companies are also sponsoring chairs. These types of partnerships have evolved from a combination of factors including declining federal funding for research, increasing awareness that university research could contribute new solutions to real world issues, globalization, and growing demand for publicly relevant research (Kelley & Randolph, 1994). Industry or government IDHR partnerships with universities take a number of forms, such as providing training or consultation, research contracts, providing specialized equipment, adjunct professorships, and technology transfer, (Kelley & Randolph, 1994). However, the majority of university linkages with government and industry are not interdisciplinary; they involve limited collaboration with individual academic researchers in one or two disciplines (Sussex Circle Inc., 2003). The extent to which such partnerships should or could adopt and interdisciplinary approach remains to be explored.

Benefits of interdisciplinary research in industry and government

It is generally acknowledged in surveys of researchers that effective collaborative interdisciplinary initiatives can result in outcomes that exceed the possibilities of uni-disciplinary research (Sussex Circle Inc., 2003). In addition, because of economic constraints, there is a diminished research capacity in some industrial companies and government departments (Portland State University, 2003). Some IDHR projects would not be carried out if industry or government relied solely on researchers they hired (Turpin, D., Garrett-Jones et al., 1999). Therefore, Taylor (2004) indicates that the advantages of conducting IDHR with the health care industry are that the researcher is able to provide solutions to real-world problems, to identify gaps in the services provided, and to bring research into the everyday lives of practitioners and patients.

The most common benefits interdisciplinary research noted in surveys of industry, government and university researchers include the fact that it enhances the development of new collaborations and research ideas and it builds long-term research relationships with researchers in disciplines not normally represented in-house (Taylor, 2004; Turpin, D., Garrett-Jones et al., 1999). For example, collaboration between pharmaceutical

representatives, researchers from various biomedical and social science disciplines, clinicians, and Health Canada have produced new insights about how clinical drug trials could be more efficacious.

In addition, there is a greater possibility for transfer of the benefits and outcomes of such research to a broader audience when there is interaction among people with diverse backgrounds and perspectives in IDHR from government and industry (Kelley & Randolph, 1994). For example, government policy makers are an important audience for IDHR in areas that have profound social and economic impact, such as obesity (Butchko & Peterson, 2004). They can also be proactive in suggesting ways in which the IDHR findings can be effectively translated into policy (Philip, Backett-Milburn, Cunningham-Burley, & Davis, 2003).

The implementation challenges

While the affinity and importance of IDHR in industry and government is obvious, the challenges in executing it are often formidable (Horwitz, 2003). The science of IDHR may not be immediately visible to the decision makers and funders in government and industry. For example, as previously noted, industry and government generally operate within well-defined hierarchies and with definite time lines. Increasingly, both industry and governments are choosing to prioritise research that can be conducted quickly, with minimal cost and delivery of a marketable product (Portland State University, 2003). Thus, the time-consuming protocols and methodologies required in IDHRH may be difficult to justify in these contexts. For instance, Canadian researchers in a cross-national study of peri-operative transfusion commented that the slow and time-consuming nature of IDHR alienated industrial scientists who were used to conducting research in a linear manner with more rapid outcomes (Treloar & Graham, 2003). In addition, because of the costs associated with licensing and implementing new products, there is a concern that industries will avoid IDHR projects that have little commercial value.

University researchers' collaborations with industry and government are not without challenges either. Many of these relate to the reward culture of the various institutions. For example, industry may submit a grant proposal directly to the funding agency. If it is approved for funding, the company, not the university, receives the credit for the grant and the university-based researcher is not viewed as contributing to the university's research dollars (DeLisa, 2004).

Communication in an industry or government-sponsored IDHR project must occur at two levels: (1) internally, communication about the research plans

> **Recommendations – IDHR in industry and government**
>
> - Research funding agencies should set aside funding for IDHR in government and industry sectors
> - Research funding agencies should create industry research studentships and calls for proposals that fund IDHR with industry or government
> - Communication in an industry or government-sponsored IDHR project must occur at two levels: (1) internally, among the members of the research team and the decision makers who are ultimately responsible for funding and support of the research; and (2) at both a local and national level, the stakeholders who will use the research findings
> - Universities should explore with research funding agencies ways in which university-based researchers can receive credit for research dollars in non investigator-initiated IDHR projects (i.e university-industry/government partnerships)

and activities must occur on an ongoing basis among the members of the research team and the decision makers who are ultimately responsible for funding the research; and (2) at both a local and national level, the stakeholders who will use the research findings must know about their relevance (Aagaard-Hansen & Ouma, 2002). This requirement generates considerable documentation (e.g., minutes from research meetings; data files, periodic reports) and administrative challenges.

Finally, intellectual property and technology transfer can be significant issues to implementation of industry or government-sponsored IDHR, particularly when such research is conducted by university academic researchers (Portland State University, 2003). Surveys of academic researchers have demonstrated that industry-sponsored research may threaten the tenets of IDHR, such as open communication among scholars and unhampered disclosure of research activities and findings (Portland State University, 2003).

Future Trends and Implications

Complexity and competition that determine the need for interdisciplinary collaborations are likely to increase as organizations undertake more "big science". The trend is clearly a movement towards interdisciplinary networks that transcend organizational barriers; with industry, government and university scientists being involved in joint ventures that target specific problems (Canada's Networks of Centres of Excellence or organisations such as Genome Canada are just two examples). Such endeavours typically target translational research and often include support from not-for-profit organizations.

> **Case study - Institute of Health Economics (IHE), Edmonton Alberta**.
> The IHE is a not-for-profit partnership that is funded by 10 pharmaceutical companies, two universities, five provincial or regional health organizations, and one federal government ministry. The goal of this organization is "to create an international centre of excellence for health economics, health outcomes, and health policy research…" IHE expands its interdisciplinarity through collaborative projects with Centres at universities outside Alberta and has projects that are funded by CIHR and by the US government's Agency for Health Research and Quality

Many of the existing interdisciplinary health research networks are international in their scope. These efforts are aided by government incentives that provide generous tax credits for research and development expenditures in Canada, as well as by an advanced optical network system called the **Canadian Network for the Advancement of research, Industry and Education** (CANARIE), which facilitates transfer of information. Government support of infrastructure and personnel through the **Canada Foundation for Innovation** (CFI), the **Canada Research Chairs** programs, and **CIHR** and organisations such as **Genome Canada,** has also facilitated interdisciplinary health research. These types of collaborations among government, industry and university organizations also arise from a risk-sharing perspective. Some of these collaborations allow the participants to explore areas with high risk and high potential returns that they might not pursue otherwise.

In summary, the features that distinguish the research environment of government and industry from that of universities can at times be either a benefit or a constraint. Care must

> **Genome Canada**, which operates its program along with partners and five Genome Centres across the country, funds only large-scale projects and has provided almost a billion dollars in research support in the past few years. Most of these projects have been in health research and almost all are interdisciplinary (www.genomecanada.ca)

be taken to consider the research context, goals and motivations in assessing whether an interdisciplinary approach is appropriate.

1.6 The Canadian Experience

> **Recommendation for Assessment:**
> *The following section details some of the main benefits and challenges at multiple levels, of conducting IDHR in Canada specifically. The corresponding chapter 2.5 in the Framework for Assessment will outlines the questions flowing from the discussion o presented here, which are then set within a program of proposed research that will seek to understand what is unique about doing IDHR in Canada and what special advantages Canada may hold for this type of research.*
> *Note: More detail on case examples can be found in the Appendices.*

Introduction

The need for clearly focused educational preparation and in-depth attention to the knowledge creation of each of the health disciplines is essential to the outcome of quality health care. However, the uni-disciplinary pursuit of knowledge in the health sciences – as for all sciences, the arts and the humanities – also has unquestionably exposed a shared

paradoxical challenge: attaining the singular aims of any one discipline will only happen if the knowledge, expertise and efforts of multiple disciplines are brought to bear (Cech & Rubin, 2004; McCarthy, 2004).

The benefits of rising to this challenge are particularly apparent in the health sciences. The inherent complexity of nature and society, the inextricable linkages between subcellular, cellular, and multicellular systems, and amongst biological, psychological, social and spiritual dimensions of humankind demand interdisciplinary (Anderson, 1998) and translational (Birmingham, 2002) research (Crist, Schafer & Walsh, 2004; Lenfant, 2003).

Internationally renowned for innovation, cooperation, and consensus, Canadians are particularly well suited for the pursuit of interdisciplinary work. Indeed, the Canadian experience would suggest that, true to their national image, Canadians are well underway in their pursuit. The Canadian respect for diversity has afforded a solid foundation for interdisciplinary and translational research in the health sciences. In addition, Canadians have demonstrated international leadership in the use of information technology, overcoming barriers created by geographic isolation, a feat that has facilitated both national and international interdisciplinary collaboration and translational research. In keeping with their inclination toward innovation, Canadians have also played a leading international role in advancing the theory and practice of health promotion, as evidenced by the Ottawa Charter (WHO, 1986), considered to be the most influential of health promotion documents (Rootman & Raeburn, 1994). The definition of health as " the ability to realize aspirations, satisfy needs, and respond positively to the environment . . . a resource for everyday living, has profoundly affected those working in the field of health and has paved the way for the population health model, which encompasses the broader social determinants of health.

Canada's international leadership in the Kyoto Accord is further testimony to Canadians' commitment to this broadened view of health. This direction, too, has invited and, indeed, necessitated, interdisciplinary research in the health sciences. With an international reputation for peace and relationship building, Canada undoubtedly is well-positioned to be a global leader in interdisciplinary and translational research in the health sciences.

Notwithstanding the advances made, both the current Canadian context and the socio-historical-cultural context of health sciences present challenges to the fulfilment of interdisciplinary and translational research in the health sciences. This chapter provides an overview of the "state of the art" of interdisciplinary health sciences research in Canada. Although the many examples uncovered serve as a testimony to past and on-going successes and illuminate facilitators of success, the persistent barriers to achieving IDHR are also exposed. These examples, together with other experiences reported in the literature, offer strategies to refine this approach to research in Canada.

In this chapter, the strategy used to document IDHR included a search of the PubMed (of the US National Library of Medicine), CINAHL (nursing and allied health literature) and PSYCInfo (psychological literature) databases for literature published in the past 15 years, using the terms: interdisciplinary research, interdisciplinary education, collaborative research, team research, interdisciplinarity, and barriers and facilitators to interdisciplinary research/work. From 677 papers identified, 25 were selected for content relevant to this chapter, 9 of which were Canadian in origin.

The authors also considered the websites of key Canadian research funding bodies (i.e., the Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Canadian Health Services Research Foundation, Social Sciences and Humanities Research Council of Canada, and National Cancer Institute of Canada) and select institutional infrastructures known to the Assessment Committee for their conduct of interdisciplinary research in the health sciences. The Assessment Committee members served as key informants, reporting case studies and examples acquired either through direct or indirect exposure. The findings of this search have been organized to present the examples at the:

(1) Macro-level, encompassing elements that shape the context of interdisciplinary health sciences research, including political, economic and socio-cultural support;

(2) Meso-level, or the more immediate institutional structural and functional context of the conduct of such work; and

(3) Micro-level, describing individuals' contributions to and experiences of interdisciplinary research in the health sciences.

Canadian Examples: benefits and Challenges

Macro-Level Initiatives

Largely unaltered by political ideological leanings, Canadians' valuing of health has led to a strong, publicly funded health-care system and, albeit less powerful and direct, support for national health sciences research. The Canadian Government has provided the impetus for interdisciplinary research in the health sciences by passing Bill C-13, the *Canadian Institutes of Health Research Act*. This legislation created the Canadian Institutes of Health Research (CIHR), linking health science and health research to clinical care and population health (Phillipson & Silverman, 2002), both intrinsically interdisciplinary in nature. As the Minister of Health, of the day, stated, "The CIHR will help to integrate health research activity by fostering linkages and breaking down barriers that have existed among the different fields of health research: bio-medical research, clinical research, research respecting health systems, health services, the health of populations, societal and cultural dimensions of health and environmental influences on health. This new approach will create a vibrant environment that will recognize the importance of collaborative research for improving the health and well-being of Canadians and for building a high quality health system" (Health Minister Allan Rock, Health Canada Online, 1999).

The growing interdisciplinary commitment of government-supported research funding institutions in Canada is readily apparent. Created in 2000 to replace the Medical Research Council (MRC) of Canada and subsequently expanded to accommodate the National Health Research and Development Program (NHRDP), transferred to it by Health Canada, CIHR is, in and of itself, testimony to this direction (Phillipson & Silverman, 2002). Previously, NHRDP encouraged and supported interdisciplinary collaboration and partnerships between academics and the health services community. Likewise, MRC nurtured IDHR within the biomedical sciences and medical disciplines with a "bench to bedside" orientation during this timeframe. In the few short years since its inception, CIHR has brought to fruition the synergistic effect of combining the interdisciplinary efforts of these previous research funding and policy structures.

The structure of CIHR has been created with the promotion of interdisciplinarity in mind. Indeed, the four research areas – biomedical, clinical, health systems and services, and population and public health, demand interdisciplinary cooperation. In addressing their overarching mandate for "the creation of new knowledge and its translation into improved health for Canadians, more effective health services and products and a strengthened Canadian health care system" (www.cihr.ca), these four pillars both individually and together call for the integration of research "from bench to bedside". The 13 institutes that comprise CIHR also contribute to interdisciplinarity in health science research by inviting a cross-disciplinary focus on: aboriginal peoples' health; cancer research; circulatory and respiratory research; gender and health; genetics; health services and policy research; aging; human development and child and youth health; infection and immunity; musculoskeletal health and arthritis; neurosciences, mental health and addiction; nutrition, metabolism and diabetes, and population and public health.

Through its functioning, CIHR has perhaps achieved its greatest contribution to promoting interdisciplinary research in the health sciences. In addition to encouraging and supporting individual interdisciplinary projects that link the disciplines within bio-medical science, medicine and other health science professions, CIHR has actively advanced the agenda of interdisciplinary research by designating funds for cutting-edge initiatives (see textbox this page). With 30% of its research funding reserved for strategic initiatives and 70% for investigator-driven research, between 1999-00 and 2003-04, CIHR achieved a considerable shift toward translational research and the funding of researchers other than bench scientists and physicians, thereby promoting interdisciplinarity. Population health research funding grew by approximately 18%, and health services research, by approximately 45%, as compared to clinical research, the funding for which grew by approximately 5%, and biomedical research, by approximately 4%, in that timeframe.

The Canada Research Chair funding initiative to attract and support outstanding Canadian researchers also has indirectly influenced the development of interdisciplinarity in the health

sciences. In 2000, the Government of Canada provided $900 million for the establishment of 2,000 research professorships known as Canada Research Chairs, in universities across the country. Thirty-two percent of the Chairs have been taken up by those in the health sciences (Government of Canada, 2005). In the past 5 years, CIHR has awarded the total sum of $60,653,157 to fund 436 Canada Research Chairs, of which 84 (19%) have been physicians.   The other CRCs represent a wide variety of disciplines, some conducting research of an interdisciplinary nature.

Other national funding bodies also promote interdisciplinarity in health sciences research in Canada. In addition to funding and supporting individual projects and programs of research that, in keeping with the actual delivery of health services, cross disciplinary boundaries, the Canadian Health Services Research Foundation has, through CIHR, supported chairs addressing health services research.

In addition, given the importance of research into the broader determinants of health, the Social Sciences and Humanities Research Council (SSHRC) similarly encourages and funds interdisciplinary health science research as do disease specific funding bodies, including the National Cancer Institute of Canada (NCIC) and the Canadian Heart and Stroke Foundation.

Beyond these vehicles, Canadian leaders continue to nurture interdisciplinary research in the health sciences. In September 2004, the Council for Health Research in Canada (CHRC) hosted a Leaders' Forum for Health Research in Canada to develop a comprehensive and integrated vision for Canadian health sciences research, to identify the key challenges facing the health research community in the next decade, to identify solutions, set priorities, and develop an action plan, and to develop key messages and strategies for use with government, the public and the media.

The issues and challenges addressed at the Leaders' Forum were not unique to interdisciplinary research; however, the recommendations call for a more effective and on-going exchange of information related to Canadian health research, consolidation of the health research advocacy effort, information-gathering to measure and manage Canada's health research enterprise, and the development of a more effective policy capacity and funding models for long-term and sustainable funding (The Leaders' Forum Steering Committee, Council for Health Research in Canada, Dec. 6, 2004). Forum participants specifically spoke to the need to attract, develop and encourage multidisciplinary researchers and to create an integrated and coordinated system of ongoing linkages and exchanges that enhance knowledge translation. Action on these recommendations will undoubtedly enhance interdisciplinary research in the health sciences.

Similarly, leaders and funding agencies such as the CIHR and CHSRF have recently begun to emphasise knowledge translation and translational research (Jacobson, Butterill, &

Facilitating Factors: Macro-Level

The macro-level message conveyed by the structure of principal funding bodies such as CIHR and the availability and prioritization of funding for interdisciplinary research in the health sciences is undoubtedly a primary facilitator of movement in this direction. The structure constitutes an organizing template that might be considered by academic and other institutions wanting to promote interdisciplinarity in health sciences research. The actual funding of interdisciplinary research in health sciences serves to entice both institutions and individual researchers toward interdisciplinary effort

Goering, 2004). This has encouraged approaches that go beyond the "science-push" model of the mid-20th century or the "demand pull" model of the last quarter of the 20th century. Instead, it promotes an interactive model that constructs knowledge transfer as a reciprocal and mutual activity involving researchers and knowledge users in the development, conduct, interpretation and application of research, exemplified by the Canadian Consensus Process (McWilliam et al., 2003). This direction is particularly important in the health sciences arena, and encourages the integration of bench to bedside research.

Macro-Level Challenges: Despite the unquestionable leadership provided by CIHR, NSERC and SSHRC to evolve interdisciplinary health sciences research, there is a general perception that this "Tri-Council" does not have sufficient interaction to optimize the production of interdisciplinary research in the health sciences. Frequently there is uncertainty regarding the appropriate council or committee to which applications for funding should be submitted. The length of funding offered (typically 3-year grants) is often too short for the achievement of interdisciplinary research aims, which, by virtue of their complexity, take longer to achieve. While the distribution of CIHR funding reflects a shift away from purely biomedical/basic research, further movement in this direction is required if the needs and priorities associated with interdisciplinary and translational research are to be achieved.

Among the macro-level challenges, the peer-review process constitutes a considerable obstacle to achieving interdisciplinary and translational health science research. Peer-review panel members most frequently enact discipline-specific knowledge and methodologies, and conventions in evaluating scholars' contributions and lack the ability to assess interdisciplinary work. Panel members' reluctance may also be linked to the fact that interdisciplinary research proposals, by virtue of their innovative nature, constitute risks particularly in a climate of scarcity. Some of this reluctance is also inevitably tied to the socio-historical hierarchy of health science disciplines, which even today creates a culture of centralized power and control reluctantly shared across the health science disciplines.

> **Recommendations – Macro Level**
> Funding agencies
> - Provide special funding opportunities for research training in interdisciplinary strategies
> - Create specialized centres to promote the forging of new disciplines from those that currently exist (McCarthy, 2004)
> - Grant principal investigator status to all key members of the research team and not to one investigator alone
> - Modify the peer review process by educating panel members about IDHR and incorporating cross-council reviewers when appropriate.
> Research societies
> - Plan conferences that foster collaboration among the life and health sciences, particularly for those who have historically had limited interaction

Perhaps the greatest challenge for the funding institutions that support IDHR is that of ensuring fair peer review of IDHR proposals. While funding bodies in Canada have done a credible job of striking review committees with representation from multiple disciplines, the experience of key informants is that these committees comprise primarily high-profile reviewers who exercise individual uni-disciplinary perspectives in the review process. Both the structure of the review process (with two assigned individual reviewers) and the high esteem of these uni-disciplinary experts mean that uni-disciplinary assessments of

interdisciplinary proposals frequently go unchallenged by fellow committee members. Indeed, few peer review committee members can actually claim to have a multi-disciplinary, if not interdisciplinary, perspective. Unfortunately, the challenge of providing fair review increases when proposals blend "bench" and "bedside" and/or biomedical and health science perspectives in unique, innovative interdisciplinary endeavours.

> Decisions regarding the allocation of funds to interdisciplinary and translational research may be distorted or thwarted by the peer review process.
>
> -- Thorngate, et al 2002)

A recent descriptive study of the adjudication of CIHR funding applications confirms this macro-level challenge to the promotion of interdisciplinary research in the health sciences (Thorngate, Faregh, & Young, 2002). To explore how group discussions and external reviews affected review committee members' assessments of applications, 306 application files for the 2000-2001 CIHR competitions in the CIHR archives were examined for: 1) the ratings of merit given by the two assigned internal review committee members; 2) the consensus rating reached after committee discussion; and 3) the private ratings made by each committee member following committee consensus. Additionally, a content analysis was completed of the written reviews and the Scientific Officers' final reports.

Results of this study revealed frequent disagreement between internal reviews and the inability to resolve disagreement by committee discussion. As disagreement between internal reviewers increased, the consensus and average private ratings decreased, indicating that controversial applications were downgraded. Importantly, there was more disagreement in committees adjudicating socio-behavioural health science as opposed to biomedical proposals. The former received significantly lower consensus and private ratings than did the biomedical proposals. Content analysis also revealed that biomedical and health science committees used different sets of criteria to judge applications. These findings expose a significant barrier to the promotion of interdisciplinary research: decisions regarding the allocation of funds to interdisciplinary and translational research may be distorted or thwarted by the peer review process.

Meso-Level Activities

Academic institutions and both public and private sector agencies in Canada also have helped to set the stage for interdisciplinary research in the health sciences through the creation of infrastructures that support this direction. Numerous research institutes across Canada have a mandate for interdisciplinary health research. Such institutes are either independent institutions or fall under the umbrella of large teaching hospitals, often partnered with universities. Some reflect a bio-medical orientation to interdisciplinarity (e.g., the Robarts Research Institute in

> **Integrating health professionals and biomedical scientists:**
>
> The Centre for Critical Illness Research, of the Lawson Health Research Institute, University of Western Ontario, originally funded by the MRC, is a multi-disciplinary team of clinical and basic scientists focused on microcirculation. These researchers address clinical issues, for example, the debilitating disease, Systemic Inflammatory Response Syndrome (SIRS). The overall goal of the team is to advance knowledge about this disease by taking a multi-faceted approach (bench-to-bedside), which includes bench research, training of future scientists (basic and clinical), and the education of clinicians responsible for giving care to affected patients.

London Ontario, the Ottawa Heart Institute). Others integrate all health professional and biomedical scientists.

Many Canadian universities have created an infrastructure that brings health science researchers into close geographic proximity, thereby providing the context for social and professional networking. Several prominent Canadian universities have faculties of health sciences (e.g., Ottawa; Western Ontario; McMaster) or Schools of Rehabilitation Sciences (e.g., UBC; McGill; McMaster). Many Canadian universities have infrastructures that more directly foster IDHR by virtue of a specific mandate to do this, often with a content focus that demands the expertise of multiple disciplines. Across Canada's institutions of higher learning, there are numerous multidisciplinary research centres focused on issues of aging, health promotion, children and youth, human nutrition, health ethics, health services delivery or other generic topics.

For example, in 1990, the University of British Columbia established its Institute of Health Promotion Research to foster interdisciplinary collaboration in research, education and community partnerships in health promotion. In the same year, the Ministry of Health of Ontario provided infrastructure funding for 13 multidisciplinary health-systems-linked research units in universities across Ontario. This initiative aimed to mobilize interdisciplinary research on a variety of topics of priority in the health-care system of that province. More recently, in 2004, the University of British Columbia established a multidisciplinary unit called NEXUS, funded by the Michael Smith Foundation for Health Research (a provincially mandated funding agency), to develop interdisciplinary methods, conduct collaborative projects, and to train researchers from a variety of health and cognate disciplines, including nursing, sociology, epidemiology, medicine, and counselling psychology.

Contractual relationships between the public and private sectors have afforded another vehicle for the development and implementation of interdisciplinary research in the health sciences. A contract between researchers at the National Research Council of Canada's Institute for Biological Sciences and a private pharmaceutical company brought together molecular biology, electrophysiology and immunohistochemistry bench scientists to develop novel therapies for Parkinson's Disease.

Recognizing that structural and funding arrangements alone are not enough, Canadian academic institutions are now beginning to move beyond infrastructures and contracts to more upstream ways of promoting IDHR. Curricula that educate life science trainees through interdisciplinary content and socialization are now underway. In 1971, the University of British Columbia established the Individual Interdisciplinary Studies Graduate Program, the first of its kind in Canada to offer doctoral degrees in interdisciplinary studies. The program was motivated by the desire to: 1) facilitate the creation of new subfields, and 2) support students wishing to amalgamate one or more existing disciplines in their advanced research endeavours. In a similar vein, the University of Western Ontario mounted an interdisciplinary doctoral program in 1999 to further contribute to this direction in the rehabilitation sciences specifically.

Meso-Level Obstacles: At the organizational level, university structures and policies themselves act as key barriers to interdisciplinary health research (Cech & Rubin, 2004). While many Canadian universities structure faculties of health sciences to facilitate interdisciplinary work, some of these structures still reinforce chasms, for instance, between Medicine/Dentistry, and the other "allied" health sciences. Often structures of this nature lead to collaboration amongst physicians representing differing medical specialties, or amongst bench scientists representing the separate branches of science, and the illusion of IDHR is thus maintained. Unfortunately, attention to the broader determinants of health and translational research is typically overlooked within these limited structures. In addition, the university structure that ties together various health science disciplines is often

> **Facilitating Factors: Meso-Level**
>
> Currently, the greatest facilitator of interdisciplinary health sciences research at the organizational level is the recent impetus toward interdisciplinary/ interprofessional education in the field of health sciences. Stimulated by Health Canada's offering of funding support for such endeavours, Canadian universities, primarily motivated to better prepare health science professionals for interdisciplinary team practice, now, as never before, are striving to create opportunities for cross-disciplinary education. While educational programs of this nature are largely in the conceptual development phase, these programs, once implemented, will undoubtedly do much to prepare the scholars of tomorrow for conducting interdisciplinary research.

understood to exist simply for administrative efficiency or to avoid the potential for power hierarchies to develop. Such motives, real or perceived, only serve to create cynicism, which impedes, rather than promotes IDHR.

Many obstacles related to promotion and tenure and departmental budgeting processes in Canadian academic institutions frequently have been identified as barriers to the conduct of interdisciplinary research (Cech & Rubin, 2004). Such obstacles are generally accompanied by a general lack of recognition for both research and graduate student supervision that cross disciplinary boundaries and a tangible lack of support in the form of space for shared initiatives and graduate program structures that could foster IDHR.

Issues regarding the ownership of intellectual property and contracts to protect patents and copyright constitute further obstacles. While ownership and monetary issues are not unique to interdisciplinary research, overcoming these challenges becomes far more complex when multiple disciplines and multiple employing agencies of the individuals who constitute interdisciplinary teams, are involved.

Recommendations - Meso Level
- Reward talented science communicators (across disciplines and to the public)
- Restructure graduate education into 'research clusters' or multi-departmental programs.
- Expose undergraduates in the health sciences to other disciplines, so that mutual trust, respect and ability to communicate across disciplines is developed (Ares, 2004) from the outset of professional education.
- In addition to the recommendations in chapter 1.4, universities should provide infrastructures and concrete organizational support for IDHR team work, including units that accommodate researchers from diverse disciplines, internal sources of funding, mentoring infrastructures to nurture junior scientists in interdisciplinary team functioning
- Consider the Boyer typology of scholarship: integration, application, teaching, discovery
- Professional organizations should assume a leading role in knowledge translation by encouraging research and research uptake through practice guidelines.

Disciplinary bastions and biases reinforce these organizational obstacles at the meso level in Canada. Interdisciplinary research efforts are often stymied by turf wars, vested interests and cliquishness (Giacomini, 2004), non-publication of interdisciplinary work (Cech & Rubin, 2004), reverence for quantity and certainty of output at the expense of originality and potential impact, and marginalization of those involved in interdisciplinary research by their discipline-specific units, including professional associations. As noted by Giacomini (2004, p. 178), "Disciplinary *cultures* shape members' identities, relationships and knowledge by determining 'what counts as work and even *whose* work counts" (Schoenberger, 2001).

The structure of doctoral education in Canadian universities creates an additional up-stream barrier to IDHR. The disciplinary-specific departments that offer doctoral programs are virtually autonomous in establishing admissions criteria, the curriculum, the composition of supervisory committees, and the standards to which the student's work will be held. Accordingly, doctoral students are 'tied' to their home departments and disciplines, and identify with their peer group within their discipline; students who are motivated to acquire some understanding of multiple disciplines face significant obstacles and must struggle to meet their goals (Teodorescu & Kuschner, 2005).

Alternatives to the university as an organizational structure for the promotion of IDHR also present several challenges. Canadian authors (Giacomini, 2004) caution against the unfamiliar new politics, conflicting accountabilities and potentially destructive reward systems of interdisciplinary institutions. Such organizations may be premised on the needs of industries and governments and may have opportunistic agenda that undermine supportive structures for substantive research requiring stable material support over time.

These structural and functional challenges at the organizational level similarly constitute barriers to knowledge translation. Not only organizational structures, but also university policies and practices, including traditional promotion and tenure guidelines, inadequate skills training, administrative support for developing contracts and memoranda of understanding, and inadequate opportunities and structures for communication amongst researchers and users of knowledge continue to stifle translational endeavours (Jacobson, Butterill, & Goering, 2004).

Micro-Level Efforts

System and organizational endeavours to promote Canadian IDHR have been well complemented by grassroots initiatives. Individual researchers not only have mobilized interdisciplinary teams and developed numerous interdisciplinary projects, but also have taken the initiative in reaching out to create national and international networks of interdisciplinary scholars. For example, a team based at Dalhousie University has developed a program of research that links several high profile researchers in genetic diagnostics, gene transfer, stem cell research and cloning, including two Canada Research Chairs, a CIHR scholar and a past CIHR New Investigator. Such grassroots initiatives engage numerous scholars in interdisciplinary research efforts and frequently serve as training grounds for the interdisciplinary scholars of the future.

Micro-Level Barriers and Disincentives: The individual barriers and disincentives to undertaking interdisciplinary research in the health sciences also have received considerable attention in the literature (Giacomini, 2004; Nicholson, Artz, Armitage, & Fagan, 2000). Perhaps nothing speaks as loudly as the real human experience of Canadian health science researchers. There remains some confusion about what constitutes IDHR, as compared to multidisciplinary research, and if and when each of these options is ideally the direction of choice. In addition, inadequate time for the requisite meetings and the difficulty of arriving at shared goals and strategies for research are also challenging, particularly in the absence of a commonly shared paradigm, language and approach.

However, the hegemony of the traditional hierarchical relationships amongst the health disciplines, the scientific "levels" of research (i.e., experimental; quasi-experimental; descriptive; and exploratory), and the paradigms germane to health sciences research (i.e., post-positivist; interpretive and critical) constitute a much greater barrier. While conscious and conscientious confrontation of behaviour reflecting this hegemony may overcome this barrier in time, firmly entrenched attitudes, beliefs and prejudices, ignorance, intolerance of diversity, and resistance to change are very real human attributes that continue to impede progress toward interdisciplinary health sciences research. As Giacomini (2004) notes, beyond the exasperation individuals confront in efforts to execute interdisciplinary research, those who actually succeed in this endeavour are prone to feelings of isolation arising from repeated mis-understanding by everyone from grant reviewers, to departmental colleagues, to journal referees.

These epistemological and ontological barriers are further reinforced by pragmatic concerns. Some health science researchers believe that an overemphasis on interdisciplinary research may dilute the disciplines: "…In this breakthrough

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Facilitating Factors: Micro-Level

The genuine, creative and constructive efforts of IDHR researchers are perhaps the greatest of all facilitators, for it is grassroots effort that ultimately achieves and sustains such directions. The opportunities for personal self-actualization that arise from the innovative work can be motivation in itself (Slatin, Galizzi, Melillo, & Mawn, 2004). Other ways in which individuals advance IDHR include:
- The intentional exercise of team-building strategies
- Mastering communication, cooperation, coordination and collaboration processes (Brown & McWilliam, 1993);
- The creation of dissemination strategies that promote uptake and the programmatic evolution of IDHR (McWilliam, 1996; McWilliam et al., 2003)

The micro-level collaborative research process has been conceptualized as: contribution, communication, commitment, consensus, compatibility and credit (Gelling & Chatfield, 2001). Personal traits and skills, research knowledge and attitudes, team skills, communication skills and mutual understanding are critical determinants of success (Lohfeld & Brazil, 2000; Northway, Parker, & Roberts, 2001).

[to] interdisciplinarity, we are losing track of the notion of discipline. It's important to remember that interdisciplinarity can only exist if there are disciplines" (Teodorescu & Kushner, 2005).

Health science researchers often are too busy to meet new collaborators and to learn a new "language". Their pre-conceptions about other disciplines are strong and they have concerns that their work may not be given recognition by any of the disciplines that intersect with it, thereby hindering their career progression. This is particularly true for junior scientists who see IDHR as a high-risk activity. Typically junior faculty members are concerned about proving themselves in their own disciplines, to meet tenure requirements and to compete successfully for funding, before they undertake interdisciplinary work.

Recommendations - Micro level
- build interdisciplinary research teams based on sustained professional relationships
- incorporate: team identification of individual and mutually shared research goals, research questions and methods; shared intellectual ownership; and communication and conflict resolution strategies.
- apply social exchange theory and team building literature, especially techniques to optimize negotiation, role differentiation and trust
- share experiences, including victories and challenges, in scholarly venues and in mentorship of junior researchers. New arenas for such discussion, such as refereed journals for IDHR, could be developed.
- Research teams should offer opportunity to question assumptions and stereotypes, and to engage members about their perspectives
- IDHR teams should establish publication and presentation protocols at the beginning of their work together

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Added to the problems of achieving interdisciplinary collaboration, are challenges in achieving translational research. Policy makers and program planners often have their own agendas. The challenge is to get health care providers (and patients themselves) to apply knowledge gained through research. Professional practice guidelines, accountability mechanisms and attention to compliance have not succeeded in overcoming the knowledge translation barriers (Lenfant, 2004).

1.7 Facilitating Interdisciplinary Health Research

In order for IDHR to occur and be successful in terms of its processes and outcomes, various facilitators need to be in place. In this chapter, we have organized the facilitators of IDHR according to the analytical framework of interdisciplinary collaboration theory (Aagaard-Hansen & Ouma, 2002). In this framework, the facilitators of IDHR include: 1) input or contextual facilitators, 2) intra-group process facilitators, and 3) moderating facilitators.

Contextual facilitators

There are several contextual facilitators of IDHR that can exist within the research institution (defined as the university, research granting agency, government, industry, or professional societies/associations). These factors include the culture of interdisciplinarity, reward structures, credit practices, and/or workload assignment procedures, as well as the quantity and quality of human and financial resources available to support IDHR, and the availability of models of best practice for IDHR teams.

The culture of the research institution can influence researchers' willingness to engage in IDHR. This culture includes "patterns of attitudes, meanings, symbols, and behaviors" that are adopted by institutions (Frost & Jean, 2003) and determine how particular modes of research and research questions are valued and reinforced. For example, funding agencies that provide calls for research that cut across many disciplines encourage disciplinary perspectives to intersect and facilitate IDHR. A President (or Vice-President, Research) of a university who makes the expansion of interdisciplinary research a benchmark of his/her career has been demonstrated to significantly influence the culture of the university as supportive of IDHR (Academies, 2004). As well, the dean's support of IDHR (in terms of space, equipment, funding) has been determined to be a significant factor in the proliferation of IDHR in particular faculties (DeLisa, 2004).

Partly in response to the move toward professionalism and specialization, universities have been typically organized around sole disciplines and are often conceptually isolated (McCall, 1990; Richardson & Cooper, 2003). This isolationism is often compounded by the geographical location of some faculties that are distant from others. There are increasing numbers of university programs that cut across academic disciplines and have relevance for a substantial number of disciplines. For example, research institutes in many Canadian universities are organized around broad themes such as health promotion or chronic illness that achieve such a goal. Although universities have begun to publicly support the notion of IDHR, the disciplinary-focused structure of most universities implies that what is valued within university culture is the independent scholar who represents a singular discipline (Birnbaum, 1981).

The workload of researchers involved in IDHR projects is often more extensive and time-consuming than those engaged in sole disciplinary projects and IDHR researchers' productivity in terms of publications and scholarly presentations may be fewer (Palmer, 1999). In addition, most refereed journals require that authors be listed in order of their contribution to the endeavour; however, IDHR teams produce manuscripts that are evidence of their unified work. The requirement that authors be placed as first, second, third and so forth. is contrary to the tenets of interdisciplinarity (Magill-Evans, Hodge, & Darrah, 2002). Similarly, research granting agencies that insist that there be only one researcher identified as the principal investigator require that IDHR researchers betray their commitment to interdisciplinarity. The usual criteria for granting recognition or appointment/ tenure/ promotion of faculty are based on the notion of individual scholarship. It is not surprising, therefore, that as researchers advance in their careers beyond the constraints of tenure application, they are more likely to explore new career directions and avenues to expand their knowledge beyond the boundaries of their discipline (Frost & Jean, 2003).

The process by which institutions assess IDHR programs is often inadequate. The peer-review process for both IDHR researchers and programs should include researchers with expertise in IDHR. Interdisciplinary research can be assessed by criteria such as the number of publications that are generated from the research that involve more than one discipline. Other indicators of IDHR success are researchers' awareness and understanding of the disciplinary knowledge of researchers from disciplines other than their own and their readiness to engage in research that crosses the typical boundaries of their discipline

(Aagaard-Hansen & Ouma, 2002). However, there is a need to develop additional criteria to determine IDHR success, as well as the need to develop means to assess such criteria.

IDHR can be particularly challenging if researchers are required to compete with each other for funding, space and recognition (Magill-Evans, Hodge, & Darrah, 2002). IDHR requires not only the physical space for research meetings and collaborative discussion but also intellectual space for rich intercourse across disciplines. Researchers who are staff of professional societies/associations, for example, must often compete for time and space to meet because professional practice issues are viewed as more immediately relevant than IDHR.

Sufficient funding is needed to allow for the regular and frequent research team meetings that are integral to the success of IDHR projects (Treloar & Graham, 2003). The support of institutional administrators in this regard is vital. In order for administrators to support the need for time, workload adjustment and space for researchers conducting IDHR, they must be convinced that the research will have many productive outcomes that benefit the university, such as raising the institutional research profile or attaining research funding (McCall, 1990). Additional supports that are required for IDHR include senior researchers who serve as mentors and supporters of less experienced researchers and librarian or information specialists who are expert in information seeking in a multitude of disciplines (Bates, 1996). Funding programs that are organized around strategic interdisciplinary topics or themes are successful in promoting and supporting IDHR.

The culture and practices of the research institution can influence students' ability and willingness to engage in IDHR, which, is often relatively invisible within university research cultures. Finding researchers with complementary strengths and interests is often a challenge for students. Students are generally admitted to programs within their own discipline and the opportunity to work as a team member in an IDHR project most often occurs as happenstance (Richardson & Cooper, 2003). In many disciplines, the supervisor's research provides a foundation for students' research and consequently, the students tend to follow research directions that are entrenched in the supervisor's discipline (Golde & Gallagher, 1999). Currently in Canada, a student who intends a career in IDHR must locate an advisor and a thesis committee who is supportive of and knowledgeable about IDHR. The student requires mentorship in the processes of successful collaboration and strategies to negotiate issues such as authorship. Furthermore, the inclusion of IDHR in a graduate thesis may not be acceptable to the university or the discipline (Golde & Gallagher, 1999).

Intra-group process facilitators

How the IDHR team interacts and functions may be facilitative of IDHR. The major attributes of a successful IDHR team are contribution, communication, commitment, consensus, compatibility, and credit (Lancaster, 1985). Contribution refers to researchers' willingness and ability to share and learn from the diverse but complementary skills and knowledge of others. The trust and commitment of research team members to interdisciplinarity are critical to the success of IDHR (Gaskill, Morrison, Sanders, Forster, Edwards, Flemming et al., 2003; Magill-Evans, Hodge, & Darrah, 2002); this entails establishing clear group norms, being willing to invest time and energy in developing interdisciplinary relationships and learning from one another, as well as being able to share

equal credit for joint work and seeking consensus, rather than domination, in decision making (Dowling & Bright, 1999).

There are many complexities in developing and enacting a truly interdisciplinary research team; these challenges arise mainly from the differing disciplinary epistemologies, discourses, goals, and traditions of research. Many "single voices" are evident in published research reports purporting to be written by a research team. A collaborative interdisciplinary research team means that all interpretations must be acknowledged as potentially valid and that one disciplinary "truth" must not be presumed to take precedence over another (May & Patillo-McCoy, 1999).

It is helpful if a research team has a previous history of collaboration with each other before the research begins (Aagaard-Hansen & Ouma, 2002). If this is not the case, interdisciplinarity among the team members must be developed through joint participation in workshops and other planned interactions (e.g., research team meetings; group discussions) before the research actually occurs. Researchers who are new to IDHR may require mentoring from a more experienced colleague in how to function within an IDHR team.

The time to plan and implement an interdisciplinary research project is greater than is typically required in sole discipline or multidisciplinary research (Aagaard-Hansen & Ouma, 2002). The maturation of ideas takes time because the perspectives of all researchers must be explored and consensus reached about each decision to be made (Nies, Hepworth, & Fickens, 2001). In addition, in order for relationships within the research team to develop so that they are truly interdisciplinary, there needs to be sufficient opportunities for them to engage one another to learn from each other and discuss disciplinary perspectives, as well as to share research plans and activities; this equates to the need for long-term research partnerships in IDHR (Gaskill, Morrison, Sanders et al., 2003; Magill-Evans, Hodge, & Darrah, 2002). Regular and frequent research meetings are critical. Some IDHR teams also publish a newsletter to inform stakeholders about their activities and to enhance the visibility of their research (McCall, 1990).

The perceived status of IDHR team members, as well as their personalities, agendas, and allegiances, can potentially result in issues of power, authority and autonomy. Effective communication between research team members and the researchers' constructive conflict resolution skills are integral to preventing and mediating such issues. Interdisciplinary differences need to be addressed in the planning stages of an IDHR project (Aagaard-Hansen & Ouma, 2002). Some authors have recommended that IDHR teams maintain a daily journal of the team's activities and how dilemmas were analyzed and addressed (Booth, Rodgers, & Aginsight, 2000; Watkins, Gibbon, Leathley, Cooper, & Barer, 2001).

Apart from the general indicators of research success, IDHR research teams need an evaluation plan with set criteria to assess aspects of interdisciplinarity in their research activities (e.g., number of proposals and publications arising from the research where both the subject matter and the authors are representative of more than one discipline; the number of concrete examples of positive health outcomes that resulted because of the IDHR) (Magill-Evans, Hodge, & Darrah, 2002). Such a plan will provide a framework for the researchers to reflect on their performance.

An IDHR team requires a coordinator who assumes an administrative role. This individual should be impartial, not aligned to particular perspectives or methodologies, committed to IDHR, and encouraging of researchers to contribute their unique skills and expertise (McCall, 1990). This person is responsible for the fiscal, human resource and time management of the research, as well as the ongoing monitoring of the collaboration of the team and, when required, intervening when the behaviours of the team are contrary to the tenets of IDHR (McCall, 1990).

Moderating facilitators

The moderating facilitator of IDHR is the researcher's ability and willingness to engage in interdisciplinary research. Interdisciplinarity is a new way of seeing the world for many researchers who have been educated to conduct research within a sole discipline (Max-Neef, in press). Despite the widespread discourse about the benefits of interdisciplinarity, many researchers are not well prepared to work with people from disciplines other than their own (Minore & Boone, 2002) and it should not be assumed that everyone has the capacity to conduct IDHR (O'Connell, 2001). Some of the suggestions about what kind of researcher is best suited to IDHR include that the individual is reflective, a skilled listener, open to the ideas of others, and one who seeks feedback (Frost & Jean, 2003; Golde & Gallagher, 1999).

Several authors have suggested that the ways in which IDHR researchers seek information and learn are different than those who work within single disciplines (Bates, 1996; Magill-Evans, Hodge, & Darrah, 2002; Palmer, 1999). Learning styles that embrace risk and newness as opportunities for learning, draw insights from a number of diverse sources, and seek stimulation through exploring unfamiliar abstract concepts can be facilitative of IDHR (Bates, 1996; Booth, Rodgers, & Aginsight, 2000; Frost & Jean, 2003). Researchers who engage in IDHR must be able to tolerate the evolving nature of such research (Booth, Rodgers, & Aginsight, 2000).

Interdisciplinarity is also fostered when the researchers have had experience and education about being a member of an interdisciplinary research team. Researchers who typically are attracted to IDHR have a well-established research career and extensive experience working with other researchers in their discipline, often across several sites. They have taken a great deal of time to develop the management skills required to negotiate multiple agendas and perspectives. However, this "learn as you go" model of developing IDHR expertise is inefficient and excludes students and new researchers.

Education in this regard may be provided by university courses (e.g., the day long interdisciplinary palliative course offered by McMaster University or the 8-month International Interdisciplinary Wound Care course at the University of Toronto), programs (e.g., the Interdisciplinary program in Women's Studies at the University of Ottawa) or seminars offered to undergraduate and graduate students.

However, interdisciplinary education is often offered as a stand-alone program and students frequently experience difficulty reconciling their education within their chosen discipline with such a model (Sicotte, D'Amour, & Moreault, 2002). Interdisciplinary education may

also occur as the result of targeted interdisciplinary training grants that provide a mechanism to connect novice researchers with mentors who share common interests and disciplinary perspectives, as well as to learn from and work with mentors in other disciplines (e.g., the CIHR-funded Transdisciplinary Hepatitis C Research Training Grant). Several researchers have indicated that learning how to work in an interdisciplinary milieu should occur in the first two years of undergraduate education in the health professions (Hall & Weaver, 2001; Headrick, Neuhauser, Schwab, & Stevens, 1995; Headrick, Richardson, Priebe, & Bergman, 1998; Horak, O'Leary, & Carlson, 1998); however, several others indicate that students need to understand their discipline first before embarking on interdisciplinary education (Carpenter, 1995; Mariano, 1999; Petrie, 1976; Wahlstrom, Sanden, & Hammar, 1997).

There have been some innovative initiatives to address the needs of doctorally-prepared researchers who wish to learn the processes and skills of interdisciplinarity. For example, Cornell University in the USA has developed an interdisciplinary research course in conservation and sustainable development that can be offered to doctoral students as a graduate minor or to post-graduates who wish to learn and have an apprenticeship experience in interdisciplinary research (Schellas & Lassoie, 2001). The cancer prevention fellowship program at the National Cancer institute offers an interdisciplinary training post-graduate program that emphasizes the complexity of IDHR and leadership skills required by those who lead IDHR projects (Chang, Hursting, Perkins, Dores, & Weed, 2005). In addition, some universities and health care institutions have offered research internships to students in the health field who wish to experience and learn about IDHR (Chaturvedi & Aggarwal, 2001; Parran, 2001).

1.8   Evaluating Interdisciplinary Health Research

> **Recommendation for Assessment:**
> *The following section details some of the main challenges to consider when evaluating IDHR in a variety of contexts – from adjudicating grants or peer reviewing papers to considering candidates for promotion, tenure and other faculty rewards.*
> *The corresponding chapter 2.6 in the Framework for Assessment outline the questions flowing from the discussion presented here. The questions are then set within a program of proposed research that seeks to assess the appropriateness and effectiveness of current evaluation practices, methods and mechanisms for IDHR.*

Funding agencies and sponsoring universities expect evaluation of both the people engaged in IDHR and the outcomes of that work. The great expectations for and investments in IDHR must be assessed to determine whether the stated objectives were achieved and assigned resources were well spent. Evaluation is also required to respond to sceptics who question the value of the current emphasis and resource allocation to IDHR. While the necessity of evaluation is clear, the criteria and process by which it should be conducted are not (Caruso and Rhoten, 2001; Giacommi 2004; Mansilla and Garnder 2003). This chapter will explore the characteristics of IDHR that are relevant to the issue of evaluation, particularly those that make it a challenging task. First, the different epistemological foundations between IDHR and disciplinary research that influence evaluation will be

discussed and the appropriateness of criteria and methods currently in use will be presented.

Epistemological foundations

As has been shown, interdisciplinary research is conducted at the intersection of two or more disciplines in order to explore: 1) a persistently unanswerable disciplinary question, 2) questions beyond the scope of a single discipline, or 3) a complex problem of societal concern. With such objectives, IDHR brings together multiple research cultures, each with its own language, theories and methodologies. IDHR begins with a pluralistic scientific base rather than the tightly cohesive paradigmatic base of disciplinary science (Kuhn, 1970). If IDHR is done well, diverse cultures integrate in an interdisciplinary environment and possibly even become a new field (e.g., neuroscience). The unique underpinnings of IDHR that distinguish it from traditional disciplinary health science research bring with them the challenge of identifying appropriate criteria of its evaluation. Stokol et al (2003, p 24) note, that it is "the integrative quality and scope of interdisciplinary research that is uniquely reflected in its objectives."

The distinctive nature of the questions addressed in IDHR also present differences from those addressed in traditional disciplinary health research that will impact upon attempts to directly evaluate IDHR. Given the complex and often comprehensive nature of IDHR questions, the scope, predictability of outcomes and timeline of the work will likely differ from traditional research conducted within a discipline. IDHR questions are often more broadly articulated than those in disciplinary research, particularly those addressing a pressing societal issue. Broad scope questions are by definition not tightly constrained, making prediction of outcome highly probabilistic and perhaps as Caruso and Rhoten (2001, p.9) observe, "not predictable at all in the typical sense." Further, Caruso and Rhoten (2001) note that IDHR encourages iterative thinking about its questions. Thus, they suggest that the same type of tangible results characteristic of disciplinary based research may not emerge from an IDHR project. Clearly, this is problematic relative to traditional standards of research and research evaluation, particularly within a university setting.

Traditional values of what constitutes 'good' science that form the bases for the evaluation e.g., within paradigm questions, demonstration of independence as a researcher, dominance of particular methodologies being promoted as 'gold standards'. How does one define a 'good/rigorous' interdisciplinary question or project? – Are criteria appropriate such as whether it will lead to the creation of an emerging field or whether a practical/societal need is addressed?

Methodological challenges

Mansilla and Gardner (2003) elaborate on the obstacles to the evaluation of IDHR, through interviews with experts from highly regarded interdisciplinary centres. First, experts cite the fact that contributing disciplines themselves often bring conflicting appraisal standards and criteria to the task of evaluating IDHR. This exacerbates the already difficult task of creating a consensus on what constitutes quality work. Second, the interviewees identified the lack of conceptual clarity around IDHR as a barrier to creating a reasoned approach to evaluation. Finally, experts noted that the lack of precedents for assessing cutting edge

work also pose a challenge to evaluation because of the very fact that the work is out on the boundaries of the current knowledge base where no benchmarks exist. They suggested that this situation requires that valid criteria for appraisal be "developed as part of the inquiry itself" (p.9).

Broader scope questions also require more people to be involved and in IDHR projects, those people are by definition of diverse backgrounds. As has been argued previously, researchers engaged in IDHR must often spend considerable time negotiating a common language, common methods and building trust among colleagues. Such negotiations extend the timeline for an IDHR project in a way not required for projects within a single discipline. Particularly for researchers in an academic setting, atypical project timelines and extraneous negotiating activities (from a disciplinary perspective) are in direct conflict with traditional promotion and tenure guidelines. Further, establishing individual contributions is often necessitated by promotion criteria; however, doing so may be contradictory, or even impossible, if the IDHR resulted in a truly integrative project.

Amidst enthusiastic editorials and commentary in the literature encouraging IDR (Cech and Rubin 2004; Fitzpatrick 2002; O'Connell 2001), many authors echo the difficulties in evaluating IDR and most importantly, go on to note the minimal efforts that have been directed toward the issue. This is likely due to the very difficulties described above (Mansilla and Gardner 2003, National Science Academies 2005, Stokol et al 2003). With specific regard to the health sciences, Giacommi (2004, p. 182) states that "it would be a methodological challenge indeed to develop an evaluative framework for determining the types and degree of interdisciplinarity in health services research and appraising its added value in the quest for meaningful, useful or seminal knowledge."

Evaluation committees largely comprise representatives of single disciplines. This is equally true for funding agencies, periodical review boards, university promotion and tenure committees, and graduate student examining committees. What can we do to change the composition of such boards? How do we identify individuals with rigorous interdisciplinary commitment/training?

Criteria for evaluation

Mansilla and Gardner (2003) conducted interviews of experts in IDR to determine how individuals in highly regarded interdisciplinary centres appraise the quality of their work. Through semi-structured interviews, institutional documents and examples of work, three areas that could reflect the acceptability of IDHR emerged:

- Consistency: This refers to how consistent the IDHR result is with multiple individual disciplinary knowledge bases that contributed to its development. Credible IDHR would ideally fit reasonably well with antecedent knowledge bases. However if the IDHR findings violated or revealed limitations in disciplinary knowledge, the burden of providing additional justification would fall to the interdisciplinary researcher. IDHR outcomes may, therefore contribute to the disciplinary knowledge base as well as to the formation of an entirely new field, but must be judged as only possible because of an interdisciplinary effort.

- Balance: The belief that the outcome of IDHR must be greater than the sum of its disciplinary parts and unique insight must be result of the integration of knowledge.
- Effectiveness: This refers to the emphasis that experts placed on the outcome of IDHR actually achieving its stated goals. Given the diverse goals of IDHR, appraisal tools and processes would necessarily vary and a 'one-size fits all' approach to evaluation is considered untenable for IDHR. In fact, these experts describe quality interdisciplinary knowledge as the 'idiosyncratic coordination of disciplinary insights geared to accomplish researchers' cognitive and practical goals' (Mansilla and Gardner 2003, p.10).

Thus the challenge for interdisciplinary researchers and those who support them is to develop meaningful evaluation procedures linked to the formative disciplinary knowledge bases and follow from IDHR's objectives. Most importantly, these procedures must reflect a balance or integration of the constituent disciplines.

In addition to the criteria developed through the framework described here, there are other immediate questions to consider when evaluating IDHR for grants, publication and promotion purposes. These are taken up in Part 2 of this document and include:

1) To what degree should traditional disciplinary criteria be incorporated into evaluation procedures for IDHR? Do we agree that there should be a reasonable fit between knowledge generated from IDHR and the antecedent disciplinary knowledge? How does one measure if the whole (brought together in IDHR) is greater than the sum of its parts?

2) Should one consider whether the researchers have 'evolved' from solely disciplinary to interdisciplinary in their language and conceptual views in evaluation?

3) What role does measuring student interest (demand for courses, enrolment patterns, etc.) in interdisciplinary course work and programs play in evaluating the outcome of educational value of them?

As Mansilla and Gardner (2003) have suggested, when evaluating IDHR, ultimately we will want to know if the whole is greater than the sum of the parts and if so, by how much. We will want to link evaluation tools and procedures to the unique qualities of IDHR objectives. However, in doing so, the resulting process may bear only a cursory resemblance to an evaluation of disciplinary research. As the experts in the Mansilla and Gardner study as well as others have observed, some of the traditional criteria utilised in evaluating disciplinary research such as number of publications are also used to evaluate IDHR. Yet the consensus suggests that such metrics are considered insufficient for IDHR evaluation.

Mansilla's and Gardner's experts concluded that such count measures avoid the issue of what constitutes warranted interdisciplinary knowledge instead, ultimately constitute a disciplinary evaluation of IDHR. Such is the dynamic tension between accepted standards of evaluating research outcomes and the requirements of new criteria that will indeed capture the essential and important features of IDHR.

Mansilla and Gardner conclude this seminal work in IDR evaluation by describing what that process should accomplish. "Such assessment should instead yield illuminating evidence to grant provisional credibility to the work in question. Thus the acceptance of an interdisciplinary insight… rests on the assumption of the inherent provisionality of understanding."

Recommendations - evaluation
- Evaluative frameworks should be developed to assess the efficacy of IDHR projects that will consider the contextual and intra-group process variables associated with successful IDHR, as well as the intensity of interdisciplinary collaboration that is required.
- The Canadian Academy of Health Sciences should maintain a database of experienced IDHR researchers to serve as reviewers and advisors to less experienced IDHR researchers.
- There is a need for research about best practices in IDHR that identify benchmarks of successful IDHR and guide IDHR teams

Journals
- Develop alternate models for presenting research findings in refereed publications so the interdisciplinarity of the research is profiled and researchers' careers and reputations are not compromised because they engaged in IDHR.
- Editors of refereed journals should actively support and encourage the publication of IDHR findings by including IDHR researchers on editorial boards and as guest editors and by providing special interdisciplinary issues.

2 AREAS OF ENQUIRY FOR CAHS ASSESSMENT

Executive Summary – Part 2

Part 2 of this document focuses on the type of research that will be necessary to assess the environment for IDHR in Canada. Specifically, it proposes 9 study projects that examine the structures, culture and incentives that either benefit or inhibit IDHR. Each project corresponds to questions raised in each major section of Part 1. These include assessing IDHR in: Academics; Granting agencies; Government; Industry, Professional Societies; along with a look at the uniquely Canadian situation for IDHR and the ways in which research outputs are or should be measured.

Taken together these 9 projects would constitute a comprehensive assessment of the climate for IDHR in Canada. However, given time and financial constraints, each can also stand alone as a discrete component of the assessment. It is anticipated that certain projects

will appeal to partners such as CIHR and NCE or professional societies; it is hoped that these organisations will support components of this research.

Regardless of the study projects that are eventually retained for implementation, some initial research is necessary to further refine the questions for the assessment. This groundwork is expected to proceed as follows:

Phase 1 (Jan-Mar 2006)
- Inventory of IDHR and IDH teaching activities in health sciences across Canada
- Establish baseline/benchmarks for assessment
- Develop typology and 'grading system' for programs, centres and initiatives inventoried

Phase 2 (Apr-Jun 2006)
- Identify and contact 60-100 IDHR groups presently functioning in Canada from which to draw case studies for the proposed study projects.
- Identify priority study projects from those described
- Identify suitable partnerships for supporting/undertaking study projects

Phase 3 (July-Aug 2006)
- Refine research questions and methodologies for priority study projects with partners

Phase 4 (Sept 2006 – August 2007)
- Concurrently undertake those study projects retained for the assessment

Phase 5 (Sept-Nov 2007)
- Prepare synthesis document and recommendations

Phase 6 (Dec 2007)
- Follow-up workshops and other dissemination activities

While the main areas of enquiry are presented here with proposed methods for conducting the research, the assessment panel recognises that it will be an iterative process to develop a research design that will lead to framing the most useful assessment recommendations.

2.1   Academics: Impact of structures, practices and governance

Within the academic environment, questions of interdisciplinarity are particularly apparent in a few key features of the university:
- Governing Acts, policies, rules and legal instruments;
- Structures such as faculties, centres and institutes;
- Training opportunities
- Hiring and promotional practices and opportunities (including into government and industry)

Each of these features should be considered when assessing the benefits and barriers to IDHR in an academic environment.

Impact of provincial university acts and other governance instruments

Provincial university acts form the basis of university governance and clearly articulate the organisational structure of a given university, often including the framework of discrete schools, faculties and departments. Each of these 'units' in turn has its own governance structure and the question remains whether this structure helps or hinders interdisciplinary research.

Proposed Project 1	Input required	Estimated cost
A collaboration with the faculty of law at a Canadian university will enable a legal graduate student to undertake a short (Master's level) project that seeks to determine the impact of provincial universities acts and other university governance instruments on the implementation of IDHR.	Identify assessment panel member to lead project and Law faculty member willing to co-supervise grad student research.	Total: $12,000 studentship
Component 1: environmental scan of selected University Acts and other governance instruments from the 16 Canadian universities having Health Sciences faculties, among others. This component will consider the limitations and opportunities for IDHR placed by the various acts.	Summer research by graduate student in Law.	See above
Component 2: case studies of at least 3 universities to determine the ways that have been used to circumvent any limitations to IDHR posed by the Acts and governance instruments, or alternatively, the ways in which provisions within these instruments have been exploited to promote IDHR. The case studies will be descriptive in nature.	1 semester by graduate student in Law.	See above
Component 3: The final phase of the project will consider data collected in Components 1 and 2 in order to make recommendations about how universities acts might be amended to be better aligned with the goals, philosophy and methodologies of IDHR.	Recommendations developed by assessment panel – 2 to 4 weeks.	See above

The role of academic centres and institutes

Research centres and institutes are academic organisational units that sit outside the traditional faculty or departmental structure. These entities have been developed in response to the desire for more flexible means of collaboration between experts from various fields around specific issues. In theory, centres and institutes provide fertile ground to produce quality interdisciplinary research and training. In practice however, there are many constraints ranging from cost and benefit sharing between collaborating departments, granting of degrees, tenure of grant funding etc.

While centres and institutes are commonplace in most universities by now, there is surprisingly little critical appraisal of these innovative organisational structures for research and training. The assessment panel recommends a project to inventory these structures and study their impact on IDHR in Canada.

Proposed Project 2	Input required	Estimated cost
A survey of centres and institutes for health sciences research.		
Component 1: Inventory centres and institutes in health sciences disciplines across Canada Metrics include: 1. Numbers of programs 2. Breadth, diversity of collaborations (disciplines involved) 3. Numbers and fields of faculty, trainees 4. Numbers of identified research projects 5. Institutional reporting structure of centre 6. Development of typology and 'grading system' to categorise these centres and institutes (benchmarks)	Graduate student summer project Identify supervisor for project and to guide #6, based on data collected	$8500 summer stipend
Component 2: Case studies – Health Sciences Centres (16+). This component is intended to enhance Component 1 by providing more in depth information on specific health sciences centres. Research Questions include: 1. Impact of collaboration in terms of research output (publications, graduates trained, policy/practice changes) 2. Any new methodologies developed within centres or institutes? 3. Uptake of the research (among practitioners and decision makers at	Select the centres for in-depth study using the typology system (#6 above) to identify success stories and challenges. Identify and hire RA or consultant to refine and frame research questions and collect data.	$10,000 remuneration $3000 travel budget

Proposed Project 2	Input required	Estimated cost
various levels) 4. What additional inputs (time, financial) are required and how does centre/institute provide for this? 5. Any other special provisions or incentives within the centre/institute (financial, space, etc)? 6. What are the reporting structures for IDHR researchers within the centres/institutes?		
Component 3: Case studies – Networks of Centres of Excellence (at least 3). Questions will be similar to those listed above. In addition, the case studies will consider the national impact of the NCEs in terms of uptake within policy, practice and commercialisation: 1. number of publications (peer review and industry) 2. number of patents (various stages) 3. other measures of IDHR to be defined	Close collaboration with NCEs – we can suggest metrics for evaluation of IDHR aspects, which will enhance the NCE program evaluation conducted in 2002.	Shared with NCE?
Component 4: Synthesis and recommendations. Considering data gathered in the three components above, the final phase will determine what recommendations and revisions could be made to: 1. Criteria for appointment, tenure and promotion within universities, licensing bodies and professional associations. 2. Methods of ongoing performance monitoring and evaluation 3. Granting of joint degrees 4. Conducting program reviews 5. Formal channels of inter-professional communication	Assessment panel members' time for critical appraisal of collected data and preliminary reports by consultant/grad student. Meeting of panel members for synthesis and consensus on recommendations.	Cost of in-person meeting of panel members $10,000?

Academic training for IDHR

Following the work of pioneers such as UBC's Individual Interdisciplinary Studies program, which dates from the 1970s, recent years have seen a rise in opportunities for formal interdisciplinary training. One notable (and recent) example in the health sciences is CIHR's Strategic Training Initiative in Health Research or STIHRs. Through this initiative, some 80 institutional applicants were awarded 5 years of funding on a competitive basis to support innovative interdisciplinary training of graduate students and post-doctoral fellows in the health sciences. This said, there seem to be fewer opportunities specifically customised for *clinical* trainees to gain interdisciplinary research skills through formal training.

Proposed Project 3	Input required	Estimated cost
Survey of formal training opportunities in IDHR		
Component 1: Inventory of all types and levels of IDHR training programs across 16+ universities (undergraduate, graduate, CME, remedial). Questions would include: 1. Number of trainees 2. Types of degrees or qualifications granted 3. Number and type of supervising faculty (disciplines and specialities represented) 4. Mentorship models used 5. Types of grants, bursaries and support available to trainees 6. Job opportunities for graduates (examples from past 5 years) 7. Trainee opinions: decision-making process, experience within the program with respect to level of disciplinary competence, supervision etc).	Included in Graduate student summer project (see Project 2, component 1 above). • Online search for basic program information. • Written surveys of program coordinators, PIs or Directors of programs and trainees	
Component 2: will seek to define some of the core competencies and skills required for IDHR. Areas to be considered include training in: 1. communication skills (across disciplines, clinical and basic sciences, and to a lay audience) 2. knowledge translation skills 3. critical appraisal skills 4. research design (understanding both qualitative and quantitative) 5. creation of evaluation criteria for competencies (including whether these skills are what government and industry require in their workforce)	Identify and hire RA or consultant with knowledge of human resources skills. Survey trainees and researchers identified through projects 1 and 2	$5000

Proposed Project 3	Input required	Estimated cost
6. does accreditation process for training programs exist? Are there currently any best practices in this domain?		
Component 3: Secondary analysis of CIHR evaluation data of the STIHRs programs as a case example of IDHR training.	Close collaboration with CIHR STIHRs program director. May need to develop specific indicators for secondary analysis according to CAHS interest.	Shared with CIHR? Cost will depend on what CIHR has done already.

Hiring, promotion, tenure practices

Many IDHR researchers believe that the traditional hiring, promotion and tenure practices of most academics faculties and departments do not consider the additional work (and sacrifices) of interdisciplinary research. Rather, only the traditional measures seem to be valorised when granting rewards and promotion. Since a researcher may sacrifice a long publication record and other academic standards of progress in favour of the time required to undertake quality IDHR, he or she will likely be overlooked by hiring and promotion committees.

Proposed Project 4	Input required	Estimated cost
Assess whether IDHR is in fact a benefit or a risk in hiring, promotion and tenure. Could standard measures of IDHR expertise assist committees in making decisions that support the development of IDHR through hiring and promotion.	This question could be framed as part of a PhD level project, including the 3 components	Total: $20,000/a for 2 years of PhD
Component 1: Case studies of decision-making practices within universities. Issues to consider include: 1. Comparison across disciplines of how promotion decisions regarding IDHR are taken. What measures are considered important? What is overlooked? 2. Are committees open to novel measures for IDHR? If so, what are they? 3. Inventory number and type of IDHR appointments vs. traditional disciplinary appointments for the past 5 years. What are the trends?	Identify supervisor (Sociology of Science, Science Studies, or Education are good candidate departments. Seek matching funding from university, CIHR or provincial funder to complete the entire PhD stipend.	

Proposed Project 4	Input required	Estimated cost
Component 2: Case studies of decision-making practices within professional societies. In addition to the above list, other issues to consider include: 1. On what basis do professional bodies grant awards and promotion? Is there a provision for interdisciplinary scholarship? 2. How can awards for service reflect commitment to IDHR?	Develop list of appropriate contacts within each governing body Identify suitable and amenable organisations for case study.	Included in PhD project (see above)
Component 3: Survey of IDHR researchers experiences of promotion and tenure. Questions to consider include: 1. What definition of IDHR is used 2. Perceived 'fit' within academic structure 3. Perceived treatment within traditional system 4. Impact of incentives or disincentives 5. Perceived flexibility and support to conduct research 6. Experience of teaching assignments 7. Experience reviewing papers and grants	Decide how to identify researchers for the survey: - Through the categorisation of centres, institutes and programs? - Through CIHR records of strategic initiative RFPs	Included in PhD project (see above)
Component 3: Considering data from components 1-3, assess and document *Best Practices* by both Universities and Professional Societies in: 1. Adjudicating IDHR expertise by hiring and promotion committees 2. Provision of incentives to undertake IDHR 3. Other ways in which committees support IDHR		Included in PhD project (see above)

2.2 Granting agencies: Federal, provincial, and private

Academic careers are made or broken on the basis of decisions made by hiring and promotion committees (discussed above); editorial boards of journals; and perhaps most fundamentally of all, selection committees of granting agencies. For IDHR researchers, getting a grant funded can be quite challenging since the measures of success are very different from traditional research. Except in cases where IDHR is specifically supported in a Request for Proposals, review committees, may be unprepared and ill-equipped to fairly judge interdisciplinary proposals. Do IDHR researchers suffer unjustly? How can

granting agencies become leaders in fostering interdisciplinary research, while still supporting strong disciplines?

Proposed Project 5	Input required	Estimated cost
Assess whether granting agencies adequately support IDHR and what policies and procedures either foster or hinder interdisciplinary work, either explicitly or implicitly.	Partnership with CIHR and/or provincial funder?	Total: $15,000
Component 1: Survey of granting agencies systems and structures in Canada. Questions to include: 1. Inventory agencies that explicitly support IDHR 2. Document how IDHR review is conducted (measures used to assess grants) 3. Consider selection panel composition (achieving sufficient expertise; managing conflicts of interest). Do agencies maintain a roster of experts? 4. Document special provision for IDHR (extended timelines, seed funding etc) 5. Document how outcomes of research are monitored and evaluated by funding agencies.	Identify and hire RA or consultant to refine and frame research questions and collect data.	See above
Component 2: Case studies of evaluation and decision-making practices within selected granting agencies. Issues to consider: 1. Compare how IDHR team grants are assessed vs. individual grants. 2. What evaluation criteria, processes and methodologies are used for IDHR? Do these differ from disciplinary research? If so, how? What indicators/measures are considered most significant when assessing IDHR? Are these measures different from those used for traditional grants?	Identify appropriate agencies for case studies, based on data from component 1	See above
Component 3: Synthesis and recommendations to granting agencies in support of IDHR	Assessment panel members' time for critical appraisal of collected data and preliminary reports by consultant / RA. Meeting of panel members for	Meeting costs

Proposed Project 5	Input required	Estimated cost
	synthesis and consensus on recommendations.	

2.3 Government: assessment of IDHR practices

Research conducted by government is often necessarily interdisciplinary. Are there lessons to be learned from government research models? Do government researchers have any special expertise in working across disciplines or is this approach so normalised that they may not even consider it novel? Who conducts research within government? Are universities and professional programs adequately preparing students to undertake research roles in government? These are some of the questions that arise when considering the practice of IDHR in government.

Proposed Project 6	Input required	Estimated cost
Assess the environment for IDHR within government at federal and provincial levels.	Partnerships with Health Canada or Industry Canada?	??
Component 1: In what ways does government undertake IDHR? Enumerate projects and their outcomes.	Identify and hire consultant / RA Generate contact list through Kevin Keough, and Alan Winter, Council of Science and Technology Advisors (CSTA)	
Component 2: Model case studies: What lessons can be learned from government based IDHR models?	Identify 3-4 models of IDHR conducted within government based on list generated in component 1 (include success stories and failures)	
Component 3: Are universities and professional programs adequately preparing graduates to assume leadership roles in IDHR for government?	Survey of mid and upper-level managers and human resources officers overseeing hiring and supervision of government researchers. Interview researchers on their experiences	
Component 4: Evaluating the effectiveness of IDHR in government 　1.　Is the process inclusive of other agencies, ministries, general public? 　2.　Does the research lead directly to policy	Based on data from components 1-3 above. Assessment panel members' time for critical appraisal of	

	collected data and preliminary reports by consultant / RA. Meeting of panel members for synthesis and consensus on recommendations.	

2.4   Industry: assessment of IDHR practices

Just as with government, research conducted within the private sector is often interdisciplinary by necessity. As described in Part 1, the emphasis is on "results based" research that seeks to develop a product or resource in the most efficient and timely manner, drawing on whatever disciplinary tools are necessary to get the job done. Additionally, career advancement for industry researchers does not depend on publication and garnering accolades within a specific discipline so their range of action is likely to be more flexible.

Proposed Project 7	Input required	Estimated cost
Assess the environment for IDRH within industry		??

Component 1: in what ways does industry undertake IDHR?
   1.   What types of projects are ID? Develop typology of models
   2.   What models work or don't work?
   3.   What can be learned from industry models of research that would benefit IDHR in Canada?
	Identify contact people within industry (through Industry Canada, Biotech BC, industry advocacy groups…)
	
	Identify and hire RA / consultant
	
	Develop typology of models and develop specific survey tools for components 2 and 3.	

Component 2: industry researchers
   1.   Who are the researchers in industry?
   2.   Are we adequately training graduates for leadership roles in IDHR for industry?
   3.   What opportunities are available for health sciences students to collaborate with industry (studentships, internships)? How are these opportunities structured?
	Depends on contacts identified through component 1	

Component 3: Evaluating the effectiveness of IDR in industry 1. Do opportunities for IDHR attract	Depends on contacts identified through component 1	

Proposed Project 7	Input required	Estimated cost
business to Canada? 2. What are the industry outputs of IDHR? 3. In what ways does industry interface with academe in IDHR?		

2.5   What is uniquely Canadian?

The panel for this CAHS assessment believes that there are circumstances and opportunities for conducting IDHR that are uniquely Canadian. It will be important to survey the Canadian context for this type of research in order to assess its unique strengths and weaknesses and to consider how best to build on Canada's particular strengths. The fact that the US Academies of Science have recently assessed their national environment for interdisciplinary research (cite text here, 2005), provides a compelling opportunity for comparison.

Proposed Project 8	Input required	Estimated cost
Assessing how the Canadian research environment might be uniquely suited to IDHR.		
Component 1: Will consider the impact of the Canadian health care environment as a benefit or hindrance to IDHR. This component could draw heavily from the US study on IDR, by way of comparison. Questions to consider include: 1. Does a socialised medical system affect IDHR? 2. Does the federal/provincial relationship in health care affect IDHR in various provinces 3. Does the medical system provide opportunities to long term research and follow-up? 4. Does a multicultural environment affect the climate for IDHR? 5. What features of health care unique to each province might benefit IDHR (example: BC's linked health databases).		
Component 2: Will consider the impact of national and provincial science and research policy environments on IDHR. Questions to		

Proposed Project 8	Input required	Estimated cost
consider include: 1. Analysis of provisions within the National Life Sciences Agenda 2. The impact of National capacity-building programs such as NCEs and STIHRs (part of projects listed above) 3. Impact of (or potential role for) the CAHS in fostering IDHR. 4. How does the National Research Chairs program foster IDHR? 5. How do National granting programs (CIHR, CFI..) foster IDHR? 6. How do Provincial granting programs (MSFHR, FRSQ, Alberta Heritage etc) foster IDHR? 7. How do fund-matching schemes foster or inhibit IDHR in provinces that support them?		
Component 3: Will consider how Canadian geography and culture may help or hinder IDHR. Questions to consider include: 1. Are reputed "Canadian values" such as tolerance, inclusions and consensus-building manifested in the health research environment? If so, to what effect for IDHR? 2. How does Canada's special relationship with the EU, the Commonwealth or the US affect IDHR collaborations? What bilateral agreements or policy arrangements exist that help or hinder IDHR either explicitly or implicitly?		

2.6 Evaluating IDHR: Assessing output measures

The success of IDHR can be evaluated on many levels. These include: consideration of its scientific merit as evidenced by peer reviewed publication, grant proposals and education materials; the contribution of IDHR to knowledge translation including government policy-making and the commercialisation opportunities to which IDHR leads in industry.

Proposed Project 9	Input required	Estimated cost
Measuring outputs specific to IDHR.		

Proposed Project 9	Input required	Estimated cost
Component 1: publication and dissemination 1. Number and type of journals publishing IDHR 2. Number and type of professional conferences encouraging IDHR 3. Number IDHR articles in past 5yrs 4. Number of IDHR articles cited by disciplinary research 5. Instances of IDHR in professional society meetings 6. Trend analysis of IDHR knowledge uptake over time and across regions compared with uni-disciplinary knowledge of dissemination	Bibliometric study using online databases. Could be considered a summer student project.	$5000+
Component 2: Knowledge translation 1. Evidence of IDHR informing policy and practice in health care and government at various levels. 2. Evidence of IDHR leading to commercialisation 3. Evidence of public engagement in IDHR		
Component 3: Professional organisations 1. How does the professional accreditation process benefit or inhibit IDHR output? 2. How does the publication process within the health professions benefit or inhibit IDHR output? 3. What are the most likely channels of positive change within the structure of professional organisations (meetings, journals, accreditation process, etc..)?	Surveys of the 6 professional organisations. Identify and hire RA / consultant or summer student	$5000+
Component 4: Generate list of the most suitable benchmarks against which to evaluate IDHR output, based on data collected in components 1-3	Assessment panel members' time for critical appraisal of collected data and preliminary reports by student / consultant / RA. Meeting of panel members for synthesis and consensus on benchmarks	

2.7 CAHS Study: prioritising suggested research

Taken together the 9 proposed projects would provide a comprehensive scan of the benefits and barriers to IDHR in Canada, along with some initial recommendations for fostering IDHR, based on empirical evidence. The projects are designed to complement each other or to stand alone, depending on partners' interest in supporting a given project or component. Regardless of which projects are retained for the final assessment, some priorities can be drawn from them, which constitute fundamental groundwork for the overall assessment. These priorities are outlined in the proposed phases below:

Phase 1 (Jan-Mar 2006)
- Inventory of IDHR and IDH teaching activities in health sciences across Canada
- Establish baseline/benchmarks for assessment
- Develop typology and 'grading system' for programs, centres and initiatives inventoried

Phase 2 (Apr-Jun 2006)
- Identify and contact 60-100 IDHR groups presently functioning in Canada from which to draw case studies for the proposed study projects.
- Identify priority study projects from those described
- Identify suitable partnerships for supporting/undertaking study projects

Phase 3 (July-Aug 2006)
- Refine research questions and methodologies for priority study projects with partners

Phase 4 (Sept 2006 – August 2007)
- Concurrently undertake those study projects retained for the assessment

Phase 5 (Sept-Nov 2007)
- Prepare synthesis document and recommendations

Phase 6 (Dec 2007)
- Follow-up workshops and other dissemination activities

3 APPENDICES

3.1 Working draft of all recommendations

Summary of Recommendations so far…

This section recaps the immediate recommendations that have been generated by the discussion of the Canadian experience of IDHR. The recommendations are based on the Assessment panel members' experience and expertise. It is a synthesis of the recommendations that appear in all preceding chapters.

Academic Training

1. Models of interprofessional education be promoted and examined as a way to enhance communication and sharing of research cultures and perspectives across the health professions.
2. Training and education should incorporate pedagogical strategies which promote interdisciplinary problem-solving and development of group process and collaboration skills.
3. Educational models need to take advantage of the fact that faculty are powerful role models and mentors by incorporating innovative strategies such as team teaching and dual mentors.
4. There is a need to develop unique models of education for clinician scientists that enable timely completion of their training.
5. Meaningful studentship and post-doctoral support is required to support training in interdisciplinary research.

Promotion and Rewards

1. Letter from post-doctoral supervisor should clearly identify disciplinary strengths of individual and benefit to Department that stress the benefit to the Department and University with respect to complementarity with relevant interdisciplinary programme.
2. Institutions should provide incentives to hire faculty who are team players.
3. A candidate for hiring or promotion should provide a clear statement of their contribution to all publications/presentations, including statements from co-PIs on peer reviewed grants that document the input in question.
4. Make merit a yearly award that is not recurring in the base salary, provide clear guidelines indicating that interdisciplinary research will receive priority for these awards.
5. Create specific prizes and grants to reward those working in interdisciplinary research (e.g., UBC has the Peter Wall Institute for Advanced Studies that funds interdisciplinary workshops and grants).

Industry and Government

1. Research funding agencies should set aside funding for IDHR in government and industry sectors
2. Research funding agencies should create industry research studentships and calls for proposals that fund IDHR with industry or government
3. Communication in an industry or government-sponsored IDHR project must occur at two levels: (1) internally, among the members of the research team and the decision makers who are ultimately responsible for funding and support of the research; and (2) at both a local and national level, the stakeholders who will use the research findings
4. Universities should explore with research funding agencies ways in which university-based researchers can receive credit for research dollars in non investigator-initiated IDHR projects (i.e., university-industry/government partnerhsips).

The Canadian Experience

1. Macro Level
- Funding agencies
    - Provide special funding opportunities for research training in interdisciplinary strategies
    - Create specialized centres to promote the forging of new disciplines from those that currently exist (McCarthy, 2004)
        - Provide funding for new ideas where adventure and risk taking are encouraged
    - Grant principal investigator status to all key members of the research team and not to one investigator alone
    - Modify the peer review process
        - spend time educating panel members about interdisciplinary research
        - consider cross-council peer review panels when appropriate
- Research societies
    - Plan conferences that will foster collaboration among the life and health sciences, particularly for those who have historically had limited interaction

2. Meso Level
- Reward talented communicators who can synthesize technical issues and communicate them effectively to cultivate understanding among the broader scientific and general community
- To foster interdisciplinary health research, graduate education must be 're-structured.' Indeed some universities have demonstrated that such re-organization is possible and have moved away from the traditional uni-disciplinary model to the development of 'research clusters' or multi-departmental graduate programs wherein graduate students are trained within a collaborative environment that cultivates interdisciplinary research.
- As students get "pigeon-holed' into disciplines at the undergraduate level, a phenomenon particularly exacerbated by professional role preparation, consider exposing students in the health sciences to other disciplines, familiarizing them at this level with the unique attributes and overlaps in the language, values, roles, mindsets, etc of those in other disciplines, so that mutual trust, respect and ability to communicate with those from other disciplines is developed (Ares, 2004) from the outset of mono-disciplinary professional education
- Incentives for interdisciplinary research could be created if Canadian universities bridged disciplinary divides by revising their recruitment and hiring practices to place greater emphasis on researchers with strong interdisciplinary backgrounds, and by explicitly including the evaluation of interdisciplinary efforts in their promotion and tenure review criteria.
- Current academic culture, and the tenure code, is based on individual performance, yet means can be introduced to provide adequate recognition of participation in research teams or groups, making allowances for the higher time and energy costs of interdisciplinary work (Giacomini, 2004).
- Similarly, credit for developing or teaching innovative interdisciplinary courses can and should be provided, particularly for junior, pre-tenure faculty.

- Provide infrastructures and concrete organizational support to facilitate interdisciplinary interaction and team work, including units that accommodate researchers from diverse disciplines, internal sources of funding, mentoring infrastructures to nurture junior scientists in interdisciplinary team functioning (Cech & Rubin, 2004; Nicholson, Artz, Armitage & Fagan, 2000)
- Consider the Boyer typology of scholarship, including the scholarship of integration, application and teaching as well as the scholarship of discovery to recognise and reward, and, thereby, promote, translational research endeavours (Jacobson, Butterill & Goering, 2004)
- Professional organizations should assume a greater, if not the leading role in collective efforts to realize the full health benefits of research by minimizing what gets lost in translation, moving beyond the development of practice guidelines to ensuring that recommendations actually influence practice (Lenfant, 2004).
- Create the infrastructure needed to take research findings from laboratories into clinical practice contexts (Birmingham, 2002).

3. Micro level
- consider testing transformative leadership strategies for interdisciplinary team research, separating out the project/program management and budgetary responsibilities to neutral ground
- build interdisciplinary research teams based on sustained relationships (Giacomini, 2004)
- incorporate: team identification of individual and mutually shared research goals (Magill-Evans, Hodge & Darrah, 2002), research questions and methods; concrete steps to achieve shared intellectual ownership of the research and related publications; and communication and conflict resolution strategies in undertaking interdisciplinary research (Slatin, Galizzi, Melillo & Mawn, 2004). As well, a reflective participatory action approach ((Magill-Evans, Hodge & Darrah, 2002) often works well in interdisciplinary research undertakings.(See , for example, the Magill-Evans et al 2002 paper for a made-in-Canada strategy for undertaking transdisciplinary research and the paper by Nicholson, Artz, Armitage & Fagan (2000) for another case example that illustrates individual-level barriers and facilitators)
- consider application of social exchange theory and team building literature, attending consciously to facilitating techniques to optimize social exchange, negotiation, role differentiation and the creation of a trusting environment (Gitlin, Lyons &Kolodner, 1994), and differentiating of cooperation, coordination and collaboration strategies to fit appropriately with the research task at hand (Brown & McWilliam, 1993).

Facilitating Interdisciplinary Health Research

1. The criteria for appointment/tenure/promotion within universities must be revised if they are to accurately represent the nature and demands of IDHR.
2. Evaluative frameworks should be developed to assess the efficacy of IDHR projects that will consider the contextual and intragroup process variables associated with successful IDHR, as well as the intensity of interdisciplinary collaboration that is required by the nature of the research and the outcomes of such research. Such

frameworks will assist researchers not only to assess the quality of IDHR but to plan IDHR so that it incorporates the necessary elements and meets the criteria for success.

3. Researchers in successful long-term IDHR programs should share their narratives about their experience, including their victories and challenges, in scholarly venues and in mentorship of junior researchers. New forums for such discussion, such as a refereed journal for IDHR, could be developed.

4. Universities should develop short-term courses and practice for doctorally-prepared researchers who wish to develop IDHR skills.

5. The Canadian Academy of Health Scientists should maintain a database of experienced IDHR researchers whose expertise in developing successful IDHR teams is well-known; these individuals could serve as advisors to less experienced IDHR researchers.

6. IDHR teams that have successfully collaborated over significant periods of time to provide a context in which IDHR is fostered and sustained should be federally funded as centres for research collaboration. Such centres would provide ongoing consultation and education about IDHR for researchers and students.

7. Interdisciplinary research proposals should be assessed by specially constituted and carefully selected review panels that are knowledgeable about and supportive of IDHR

8. Research funding agencies and universities should implement workshops and other educational sessions to teach about research methodologies and approaches to researchers that typically do not incorporate these in their disciplines.

9. Universities should convey their commitment to the pursuit of IDHR by providing sufficient funding and space for IDHR, by ensuring that faculty who re engaged in IDHR have workload assignments that take into account the demands of IDHR, by revising the criteria for hiring, tenure and promotion to account for the nature and demands of IDHR, by providing faculty and student educational programs and sessions about IDHR, by providing awards for faculty and students who engage in IDHR in an outstanding manner, and by promoting the IDHR that exists within the institution.

10. IDHR research teams should build into their work ongoing opportunity to question assumptions and stereotypes, as well as to engage with other members about their personal and disciplinary perspectives

11. There should be targeted research funding programs that are organized around strategic interdisciplinary topics or themes

12. There needs to be alternate models for presenting research findings in refereed publications so the interdisciplinarity of the research is profiled and researchers' careers and reputations are not compromised because they engaged in IDHR.

13. Editors of refereed journals should actively support and encourage the publication of interdisciplinary research findings by including IDHR researchers on editorial boards and as guest editors and by providing special interdisciplinary issues

14. IDHR teams should establish publication and presentation protocols at the beginning of their work together

15. Strategies should be developed to promote research team self-reflection and intentionally permeable boundaries (e.g., exercises to clarify each other's understanding and roles)

16. There is a need for research about best practices in IDHR that identify benchmarks of successful IDHR and guide IDHR teams
17. Prizes and awards should be given by research institutions and research funding agencies in recognition of exemplary IDHR

Additional Recommendations: Assessment Panel Meeting April 18, 2005

The following comments and recommendations stem from the first in-person meeting of the assessment panel. Many of these comments form the basis of the proposed studies outlined in part 2 of this document. They are presented here in unedited, for the record.

1. An inventory is needed to identify the programs doing IDHSR in Canada which now exist within academia. It was estimated that there will be between 60 – 100 such groups. What types of problems are they addressing? Where is their funding from? How do they function?
2. Identify what kinds of training these researchers had. Whether they themselves were trained and where. Whether they were "self taught" or through the experience of being part of an IDR team
3. What kinds of training programs are available for IDHSR in Canada? How are they supported? What types of experience do they provide?
4. What kinds of ID Bachelor degree programs exist presently and where? Do they have an interdisciplinary "experience" as part of their training?
5. What ID teams and IDR exists in Canada in our industries and governments?
6. What kind of training have individuals in industry and government had? What kinds of ID projects do they work on?
7. What "uniquely Canadian" ID experiences exist? Why?
8. An inventory of ID web sites in Canada should be undertaken. What is on them? What information could be collected from them? How are they maintained? How are they used in research?
9. The types of procedures that exist for the evaluation of IDHSR need to be explored both regarding grants and journal articles. In addition, the methods used to evaluate the outcomes of research and the development into policy and funding need to be assessed, and tabulated.
10. The Universities Acts of various provinces needs to be analyzed as to how they could influence IDR and what would be involved in changing the acts to enhance IDHSR.
11. Barriers to publications of IDHSR need to be defined. Perhaps evaluating and assessing how IDR groups publish and what self-declared ID researchers do about publications and dissemination of their work could be undertaken. This could be approached as a knowledge translation process.
12. ID publications produced by HS researchers in Canada need to be reviewed and assessed. Where they are published? How are they cited? How often are they cited? Are they used in the development of policy?
13. Centres and Institutes within universities (and hospitals) are often thought as to have been formed in order to do and facilitate IDR. Do they actually do interdisciplinary work? Assessment as to how much IDHSR they do should be undertaken. Where do networks fit in? How much IDHSR do they facilitate?

14. The panel needs to understand how it is that (the many ways in which) individuals from different disciplines come together to do IDHSR and try to define the many ways they work together.
15. The panel wishes to try to define the systems and structures in Canada that are needed to support IDHSR.
16. The panel needs to find a way to describe the product(s) of IDHSR and measure output(s). Part of this includes being able to evaluate how rapidly the evidence is taken up and utilized in developing policy (knowledge translation) and appears in practice. What measurements are there for this kind of transfer?
17. Are there leadership courses that help to develop these IDR and leadership skills, e.g., such as the Banff or Rottman courses.
18. Art Carty needs to be engaged to help define what is happening elsewhere within government regarding the value and use of ID models.
19. The public needs to be engaged to understand that IDHSR is useful and what the socioeconomic benefits may be.
20. The career development of ID researchers could be benchmarked by identifying ID jobs, how many jobs are advertised as ID, and whether they are filled by functional ID researchers.
21. The panel wants to look at mechanisms that have or might stimulate IDHSR in Canada.

3.2   Immediate Measures: what can help now?

The following is excerpted from a draft working document under development by the assessment panel outlining suggestions to granting councils for building a new "grant architecture" and adjudication procedures that would foster interdisciplinary research in the health sciences.

Working (operational) definition of IDR from the Assessment panel:
"Interdisciplinary research involves a team of researchers from different disciplines that comes together around an important and challenging issue, the research question for which is determined by a shared understanding in an interactive and iterative process"

1. A different process needs to be developed for interdisciplinary research (IDR) proposals than is currently used for discipline specific projects and proposals. Truly interdisciplinary proposals need different guidelines, and different time frames-- usually a longer period of time to develop after the call for a competition (6 months rather than 2 months). Seed funding is often needed for establishing collaborative teams or networks (e.g., web site, meetings, telephone conference). Different measures for judging success in completing the research and in being eligible for PI(s) of a grant is also needed (not just the number of publications or first author publications rather evidence that they are working together, such as documenting meetings, joint papers, trials, etc.). Suggestions to granting agencies for consideration include the recognition of the importance of previous joint conferences and publications (e.g., policy papers, interdisciplinary journals, Cochran reports, etc.) and other impacts (other than publications and conferences) such as establishing new teaching programs (particularly graduate programs), new

research centres, a new public policy developed, and training and mentoring outstanding new researchers. In other words, a different type of evaluation(s) and standard(s) is needed for ID researchers (and IDR projects), their ability to do research, and what the deliverables will be. There is a reflection of the readiness of the group to do research together.

2. We are proposing that the review team or adjudicators must understand interdisciplinary work. Other jurisdictions such as the EU have a registry of interdisciplinary health science research expertise to use in reviews. This registry is used to identify appropriate adjudicators. Interdisciplinary scholars sign up on an electronic database on a voluntary basis. The list is updated each year before the selection of evaluators for a given competition is made. The evaluators for a particular competition are then selected on the basis of their expertise, reputation, and suitability for a particular panel in a way in which they do not have conflict of interest. In Canada, there are several centres which are "training grounds" for this kind of experience such as the University of Alberta's Interdisciplinary Program, Peter Wall Institute for Advanced Studies at UBC and various institutes and centres at McMaster. Such a list of experienced ID researchers could be developed in Canada. Again the process of evaluation may be different than the "discipline" approach of averaging scores. If such a team cannot be brought together for a particular project, the adjudications will need orientation. In particular, a panel is asked to adjudicate a whole series of grants orientated to the group, the methodology, and the project will be essential. The language of various disciplines carries nuances that need to be appreciated in order to evaluate the proposals appropriately.

3. The adjudication process should include an evaluation of how the hypothesis was developed and include examples of the communication that has occurred between the research team members, the meetings they have had could be documented (that they have met jointly to formulate the project or they have had done previous interdisciplinary work together), and their methods of communication should be evident. The research question and methodologies must be rigorous. This may also require an alternative to the usual review committee process of averaging scores.

4. The research team must be able to demonstrate their partnership. There may not be a principal investigator, but rather a team effort and the team must demonstrate their record of past interdisciplinary work. However, this is not meant to disqualify new or young researchers who have or are developing an interest in IDR. Their "new" commitment can be documented in many ways.

5. In the grant proposal, the development of a research question (hypothesis) and the research proposal must be an iterative and interactive process. The adjudication panel must be demonstrated to be able to evaluate the process by which the members of the team are involved and engaged, and that they may well be developing a new methodology. Various parts of the project may be developed over time, but they should be clearly related to the overall project—thus a time table should be included, but flexible. In community based research for instance, the community or the subjects need to be part of the development of the hypothesis.

Adjudication of IDR projects should include a way of evaluating how the group defines themselves, what their combined expertise is, and how they frame the question utilizing the competencies of the various individuals. They must demonstrate that they are approaching a new problem that requires the combined expertise and why it has not been resolved previously.

6. The researchers on the grant should not necessarily be assessed by the number of first author publications, but rather by whether they have demonstrated interdisciplinary team research successes.

7. The IDR grant should include a clear strategy for dissemination of the results.

8. The deliverables of interdisciplinary research projects should be defined within the proposal.

9. It may well be that the granting agency needs to provide a team with seed grants for the interaction of groups, prior to large proposals being submitted particularly if they have not interacted before.

3.3   List of 'clients' of IDHR

National funding agencies: CIHR, SSHRC, NSERC, NCIC, CHSRF, CFI

Governmental national health agencies: Health Canada, Public Health Agency

Provincial government staff: ministers and deputies of Advanced Education and Health

Provincial research foundations—Michael Smith Foundation for Health Research; Alberta Heritage Foundation for Medical Research; Fonds de la Recherche en Sante du Quebec; Nova Scotia Health Research Foundation; New Brunswick Medical Research Foundation; BC Medical Services Research Foundation; Saskatchewan Health Research Foundation; PEI Health Research Program; Memorial University Medical Research Foundation; Manitoba Mental Health Research Foundation; Atlantic Aboriginal Health Research Foundation;

Non-government sponsored research institutions (e.g., Ottawa Health Research Institute; Centre for Advancement of Health in Calgary; Centre for Addiction and Mental Health; Newfoundland and Labrador Centre for Applied Health Research; British Columbia Homelessness and Health Research Network; Traffic Injury Research Foundation; Juvenile Diabetes Research Foundation; Nightingale Research Foundation; Canadian Psychiatric Research Foundation; Centre for Health Services and Policy Research; Nursing Health Services Research Unit; Arthritis Community Research and Evaluation Unit; Supportive Cancer Care Research Unit; Centre for Advancement of Health; Canadian Foundation for AIDS Research; Imasco -CDC Research Foundation; Down Syndrome Research Foundation; Borderline Personality Disorder Research Foundation; Meningitis Research Foundation of Canada; Vancouver Island Prostate Cancer Research Foundation; Prostate Cancer Research Foundation of Canada; EB Medical

Research Foundation; Northern Cancer Research Foundation; Retinitis Pigmentosa Eye Research Foundation; the Common Cause Medical Research Foundation; Rick Hansen Man in Motion Legacy Fund; Canadian Foundation for Dietetic Research, Canadian Fitness and Lifestyle Research Institute;

Interdisciplinary training/education programs: College of Health Programs (UBC); National Research Training Program in Hepatitis C;

University-based research institutes/units: McMaster = Health Information Research Institute & CLEAR Unit; Dalhousie Population Health Research Unit; U of Manitoba = Centre for Aboriginal Health Research; Waterloo = Centre for Applied Health Research; Lakehead & Laurentian = Centre for Rural and Northern Health Research; University of Saskatchewan = Institute for Health and Outcomes Research; Simon Fraser = Institute of Health Research and Education; Memorial: Institute for Social and Economic Research

University Staff: VP Research and VP Academic; Research Chairs

Centres of Excellence: Centres of Excellence for Women's Health;

National university/community College Associations: CAUT; AUCC; Canadian Association of Schools of Nursing

Professional societies, associations and colleges: Canadian Anesthesia Research Foundation; Canadian Consortium for Health Promotion Research; Canadian Association of General Surgeons; Canadian Association of University Research Administrators; Canadian Association of University Continuing Education; Dietitians of Canada; Canadian Physiotherapy Association; Canadian Medical Association; Canadian Nurses Association; Canadian Association for Nursing Research; Canadian Consortium for Nursing Research and Innovation; Canadian Organization of Medical Physicists; Canadian Psychological Association; Canadian Society for the Study of Higher Education; Statistical Society of Canada; Association Canadienne-Française pour l'avancement des sciences

Prime Minister's Office: Art Carty and CSTA

Hospital or health agency-based research units/centres: St. Michael's Hospital's Inner City Health Research Unit; Thames Valley Family Practice Research Unit; Research Institute, Hospital for Sick Children; Culture and Mental Health Research Unit of the Department of Psychiatry, Sir Mortimer B. Davis-Jewish General Hospital; Lawson Health Research Institute; Newfoundland Cancer Treatment and Research Foundation; Children's Hospital Foundation of Manitoba; Isaak Walton Killam Hospital for Children Research Unit;

Editors of health research & interdisciplinary research journals: Qualitative Health Research; Canadian Health Services and Policy Journal; Journal of Interprofessional Care; Entropy; Hygeia Internationalis; Interdisciplinary Science Reviews; Margins; Psyche; Psychiatry, Psychology and Law; Syntax

Private Foundations: Change Foundation; Canavan Research Foundation; Vancouver Foundation; BC Endocrine Research Foundation; Banting Research Foundation; the

Hamilton Foundation; Henry M. and Lillian Stratton Foundation Inc.; James Pickler Foundation; Josiah Macy, Jr. Foundation; Max Bell Foundation; Whitaker Foundation;

Research Transfer Initiatives: Canadian Cochrane Network & Centre;

Non-profit associations with research competitions: The Kidney Foundation of Canada; Easter Seal Society; Lung Association of Canada; The Liver Foundation; Canadian Diabetes Association; Canadian Mental Health Association; MS Society of Canada; Lymphoma Foundation Canada; Alzheimer's Association; Huntington Society of Canada; Cancer Research Society Inc. (Montreal); Canadian Genetic Diseases Network; Canadian Foundation for Ileitis & Colitis; Canadian Foundation for Ileitis & Colitis; Canadian Foundation for the Study of Infant Deaths; Canadian Friends of Schizophrenics; Canadian National Institute for The Blind; Canadian Heart Foundation Immune Deficiency Foundation; Asthma Society of Canada; Victoria Heart Institute Foundation; Canadian Paraplegic Association; Parkinson Society of Canada; Spina Bifida and Hydrocephalus Association of Canada; Heart and Stroke Foundation; Kiwanis Club Medical Foundation; Muscular Dystrophy Association of Canada; Canadian Association of Gastroenterolgy; Canadian Association of Cardiac Rehabilitation; Canadian Association for School Health;

Research interest groups/associations: Alberta Consultative Health Research Network; Canadian Association for Nursing Research**;** Canadian Association for HIV Research; Canadian Association of Research Ethics Boards

Advocates: Down Syndrome Research Online Advocacy Group; BC Centre for Disease Control (has a program for advocacy among people with HCV); Canadian Association of Retired Persons; Colorectal Cancer Network;
Should we include industries (e.g., pharmaceutical companies) that sponsor research?

3.4   Selected Case Examples

This section may be deemed unnecessary. If it is included, it is suggested to categorise the collected examples under the following headings: Funding; Training; Recruitment; Networking; Centre/Projects. See boxes in text.

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