Research Strategic Plan 2012-2017

Background

The Faculty of Medicine (FoM) with its partner University of Toronto (U of T) hospital/research institute full affiliates constitute a major national resource in health and biomedical research that has achieved international recognition in many fields. In the 2011 Global Rankings, the Times Higher Education places the University of Toronto at 17th of the world's top universities in research, teaching and knowledge transfer. In 2011, the Higher Education Evaluation and Accreditation Council of Taiwan, that focuses on research bibliometric analysis of 500 research-intensive universities world-wide, ranked U of T ninth, and in the sub-category of Clinical Medicine for World Universities U of T ranked fourth. This success rests, in part, on the depth and breadth of the research enterprise in the FoM that accounts for more than half of the total research funding obtained by the UofT. According to a 2011 Thomson-Reuters survey, the U of T topped 15 fields in Canada in total citations: chemistry; materials science; engineering; space science; mathematics; ecology/environment; clinical medicine; immunology; biology and biochemistry; molecular biology/genetics; neurosciences; pharmacology; psychology/psychiatry; education; and economics and business. When examining impact (average citations per paper), the U of T ranked first in Canada for five fields: engineering, microbiology, biology & biochemistry, molecular biology/genetics and education.

In 2010/2011, in the FoM there were 1,613 researchers holding research funding, who obtained 8,317 research grants and contracts from internal and external sources, and total research funding (external and internal to U of T and its affiliates) of $792 million. The extensive health research enterprise across the U of T and affiliates captures greater than 20% of the Canadian Institutes of Health Research (CIHR) national funding, with the majority of these researchers appointed in the FoM. U of T Medicine, along with other Health Science Faculties and the nine fully affiliated hospitals/research institutes, together form the Toronto Academic Health Sciences Network (TAHSN) Research Institute. TAHSN houses 125 Canada Research Chairs and two recently awarded Canada Excellence in Research Chairs. Our exceptional graduate education programs are distributed across 15 graduate departments with over 2,000 masters and doctoral graduate students engaged in research. U of T Medicine also trains the largest number of physician-scientists compared to other research-intensive universities in Canada, through its Clinical Investigator Training and M.D./Ph.D. Programs.

Through improvements in education, health care and wealth Canadians are living longer and leading more active lives than ever before. While we have enabled relative longevity, many individuals are living with long-term chronic disease that requires the availability of high-quality health care. The health care system has reached a challenging level of complexity and cost requiring more focus on disease prevention, health promotion and community-based care to enable Canadians and others around the world to live healthy, productive lives.

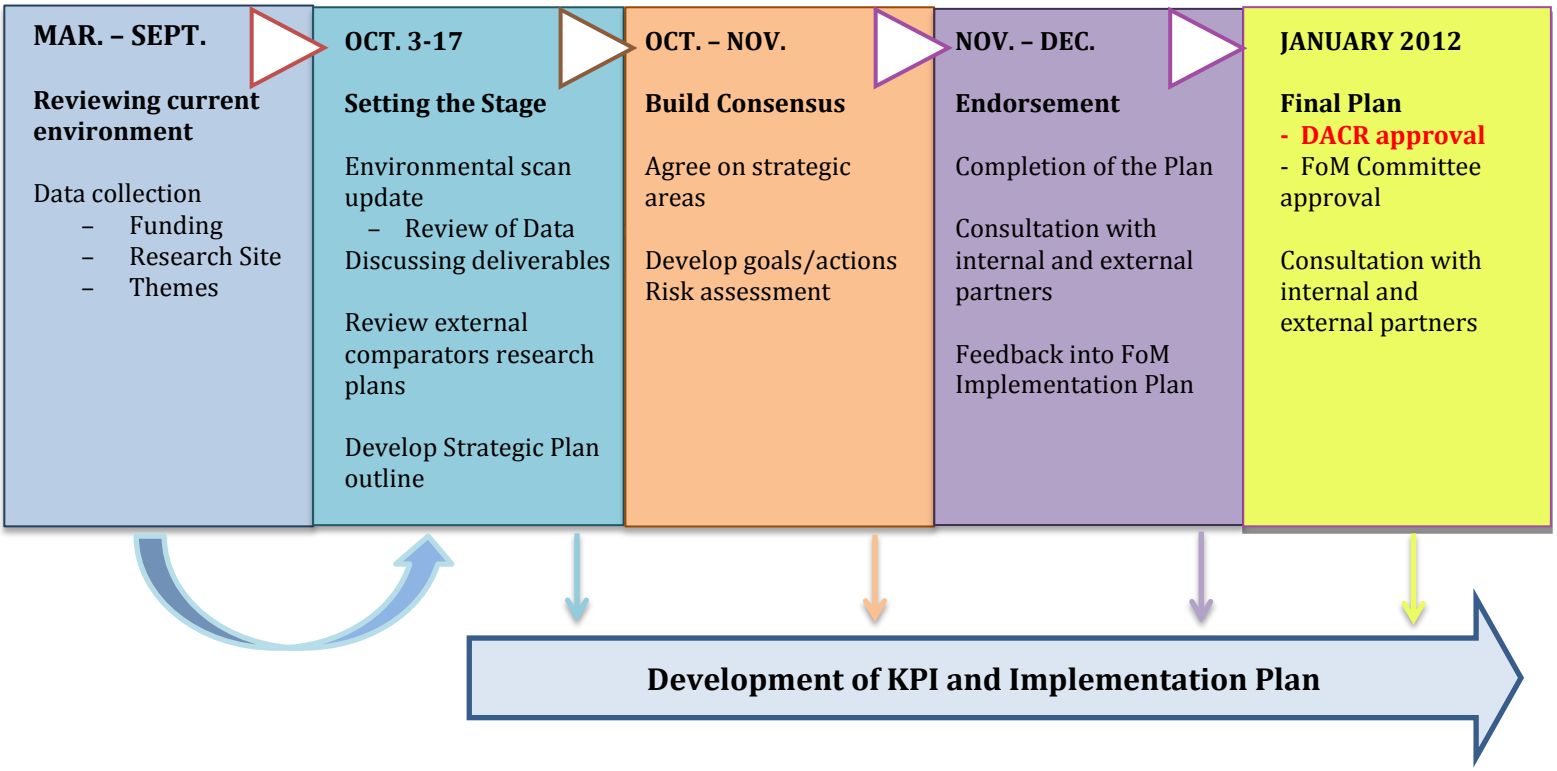
U of T Medicine has contributed to the understanding of fundamental mechanisms of disease and improved diagnostics and therapeutics. From the early days of Banting and Best, through the stem cell discoveries of Till and McCullough our researchers are consistently at the forefront of new discovery and implementing these discoveries to the benefit of our societies. U of T Medicine must step forward to lead the development of transformative solutions for the challenges created by an aging population and the rise of complex, chronic disease trajectories. It is no longer sufficient to study genes, cells, organs or diseases in isolation – an integrated approach must be applied. While diabetes is primarily caused by lack of, or non-responsiveness to insulin, the consequences of diabetes affect multiple systems including neural, cardiac, vascular and renal. The impact of this disease on the quality of life of the individual and their communities can be devastating. In order to fully understand disease we need studies that span molecules to populations.

U of T Medicine's Strategic Plan 2011-16 emphasizes three goals: INTEGRATION, INNOVATION and IMPACT. The first of these – INTEGRATION - will be a primary focus of the implementation of the new Research Strategic Plan. U of T Medicine will support existing and develop new major cross-cutting initiatives that take advantage of the breadth and depth of the research talent pool available within the U of T/TAHSN partnership. These initiatives will integrate researchers from differing departments/disciplines and health professions to focus on common, complex problems. Examples of these initiatives are the Donnelly Centre for Cellular and Biomolecular Research, and the recently created Institute of Human Development. At the same time, we will work in partnership with Departmental leaders to ensure that disciplinary research and graduate education remain at the forefront of their respective fields. Successful leadership in inter-disciplinary and inter-professional research requires that the core fields contributing to these integrating initiatives are resourced and strongly supported.

In Fall 2011 under the leadership of Professor Alison Buchan, Vice Dean Research & International Relations, members of the Dean's Advisory Committee for Research and invited faculty leaders formulated a transformative five year Research Strategic Plan (2012 - 2017) for U of T Medicine.

The plan aligns directly with the six overarching goals of the U of T Medicine Strategic Academic Plan 2011-2016 and six Strategic Objectives of the University of Toronto's 'Excellence, Innovation, Leadership' Strategic Research Plan 2012-2017.

Figure 1: Strategic Research Plan 2012-2017 Project Overview



Current Status: Environmental Scans

The strategic planning process involved a comprehensive scan of the research activity within the FoM. The geographic location of a researcher in the FoM/TAHSN community; their funding and research focus were identified for the 2,131 faculty who have held research grants/contracts in the past four years (see appendix A for complete report). The areas of research focus were initially drawn from a database created by U of T's Office of the Vice President, Research; this was subsequently modified to fit the U of T/TAHSN community. The research areas were clustered into areas of critical mass and strength based on the activity of the researchers and the research directions of the Departments/Extra-Departmental Units and Hospital Research Institutes. These areas directly correlate with the following University of Toronto Strategic Research Themes: PROMOTE - ENGAGE - ADVANCE – ENABLE.

The environmental scan identified that U of T Medicine researchers are engaged in the full spectrum of the health research continuum, ranging from biomedical to health systems research. Our unique size and scope is the result of the combination of the U of T with its affiliated hospitals/research institutes. The breadth and depth of the health research enterprise places us in an exceptional position for discovery and innovation. By capitalizing on these strengths through increased INTEGRATION across disciplines and health

professions U of T Medicine and partners are poised to expand our global leadership and IMPACT.

The commonalities between the existing strategic plans of U of T Medicine and its nine fully affiliated TAHSN Hospitals were identified. In Figure 3 the size of the individual word reflects the number of Institutions identifying the term in their plan. Health Research was clearly articulated as a major focus among all institutions.

A similar scan of Research Strategic plans (where available) for U of T Medicine's Departments, Extra-Departmental Units and TAHSN Research Institutes provided a number of commonalities, shown in Figure 4.

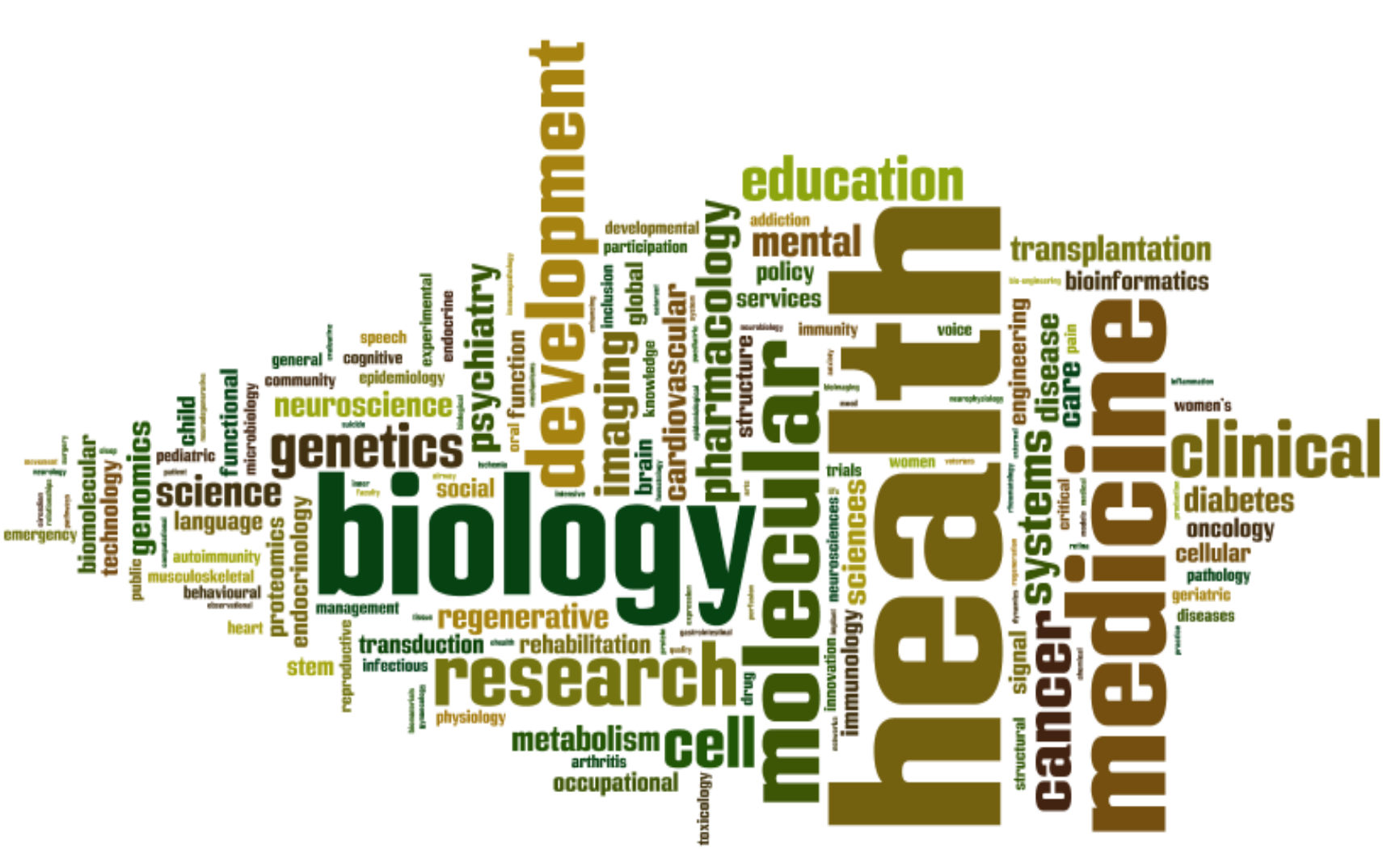
Thematic Areas

The commonalities identified from the Strategic Plans/Areas of emphasis were clustered into 18 related thematic areas (see appendix 1 for clustering) based in part on those areas previously identified by the Vice President Research. The 2,131 active health and biomedical science researchers identified in the last four years in the U of T Medicine databases have been assigned to a maximum of two themes; once the plan is finalized researchers will have the opportunity to ensure their assignment accurately reflects their current research focus. Given the complex and dynamic nature of health and biomedical research it is not uncommon to find researchers aligned with multiple areas, an indication of the inter-disciplinary nature of the work they do. For example, a geneticist may be working the field of cancer, a biochemist in neuroscience, an epidemiologist in infectious disease.

Figure 2: Alignment of the Research Strategic Plan with U of T Medicine's Strategic plan and the University of Toronto Research Strategic Plan

Figure 3: Faculty of Medicine & TAHSN All Strategic Plans: Commonalities

Figure 4: Departmental/EDU & TAHSN Research Institute commonalities



Researchers by Thematic Area

Theme	Number of Researchers	Theme	Number of Researchers
Bio-Engineering/Tech. Development	47	Infection/Immunology/ Inflammation	214
Cancer	422	Metabolism/Nutrition	118
Cardiovascular	217	Musculoskeletal	136
Computational Biology	64	Molecular Cell Biology	79
Clinical Research	253	Neurosciences/Brain Health	474
Development/Child/ Maternal Health	288	Drug-Development/ Toxicology	74
Education/Knowledge Translation	154	Population Health/ Global Health	388
Genetics Genomics-Proteomics	257	Regenerative Medicine	111
Health Services/Policy	187	Imaging	129

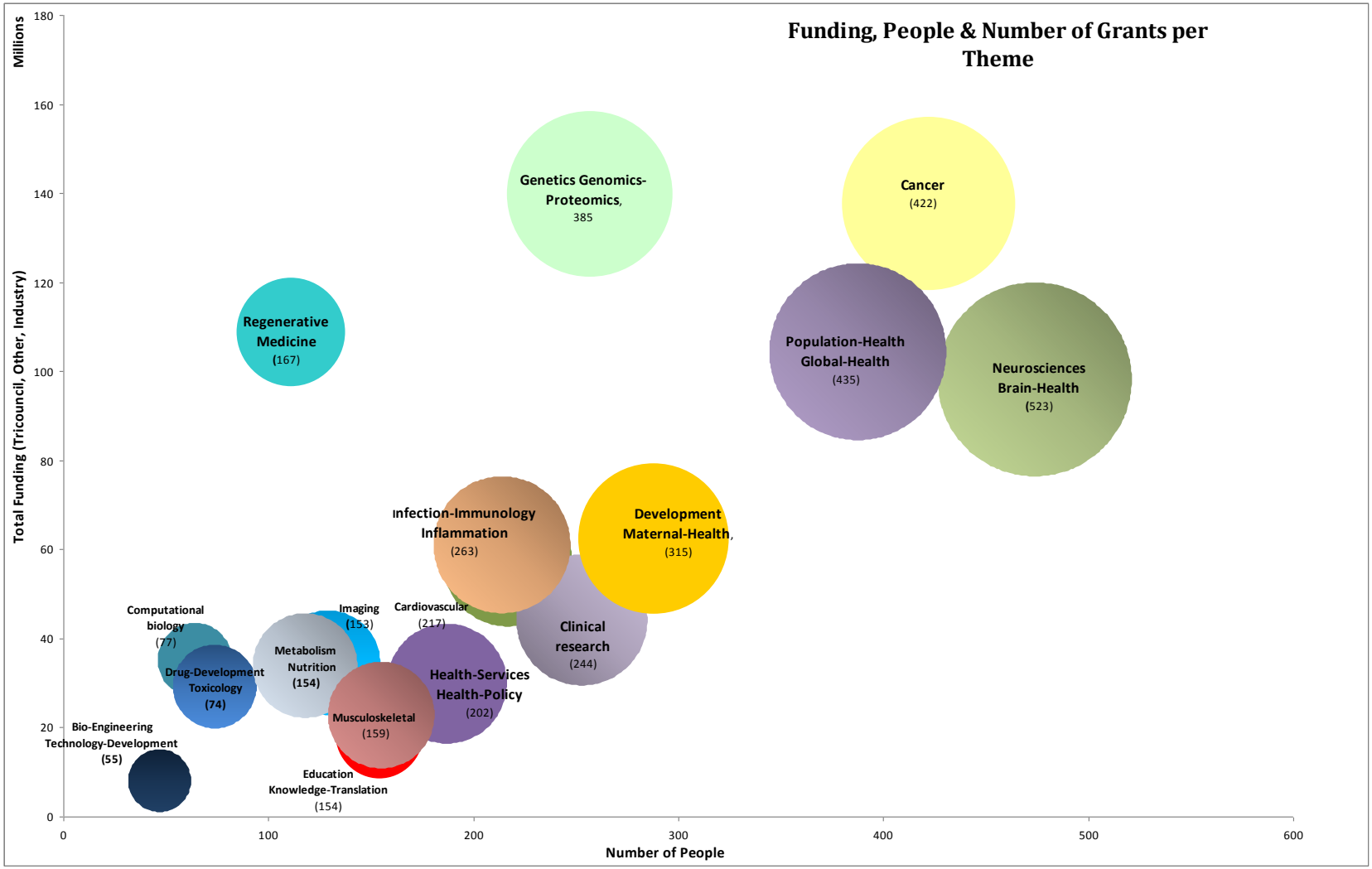
Funding 2009 -10 by Thematic Area*

Theme	Funding (M)	Theme	Funding (M)
Bio-Engineering/Tech. Development	$8.0	Infection/Immunology/ Inflammation	$61.0
Cancer	$138.0	Metabolism/Nutrition	$34.0
Cardiovascular	$57.0	Musculoskeletal	$23.0
Computational Biology	$35.0	Molecular Cell Biology	$32.5
Clinical Research	$44.0	Neurosciences/Brain Health	$98.0
Development/Child/ Maternal Health	$62.5	Drug-Development/Toxicology	$29.0
Education/Knowledge Translation	$18.5	Population Health/Global Health	$104.0
Genetics Genomics-Proteomics	$140.0	Regenerative Medicine	$109.0
Health Services/Policy	$30.0	Imaging	$34.0

*#Researchers & Funding reflects some double counting for individuals assigned to more than one theme.

Figure 5: Critical Mass of Researchers/Theme
(Size of word reflects number of researchers in topic)

Figure 6: Graph of Researchers (x axis), Total funding per Theme (y axis) and Number of grants (in brackets)*.



*The above graph combines information on first and second thematic assignment, therefore double counting those researchers assigned to more than one theme as well as their funding grants

Future Directions: Strategic Priorities

Emerging from the above analysis are four U of T Medicine Research Strategic Priorities involving initiatives that have INTEGRATION – INNOVATION – IMPACT as key components and that deliver on the mandate of discovering and implementing new knowledge that answers questions of societal relevance. The breadth and depth of health research expertise within U of T Medicine/TAHSN provides the unique opportunity to nucleate initiatives that bring together researchers from across the entire U of T community to address challenging, complex problems that cannot be solved by individual units alone. Each of these priority areas are interlinked and build on one another to address the most important societal issues – promoting health and preventing/ameliorating the effects of disease.

The four priorities are based on current and developing health research expertise in the U of T Medicine/TAHSN research community and address critical challenges. These investigator-initiated research programs cross multiple Thematic Areas as defined above, and bring together researchers from multiple Departments/EDUs and Institutional partners.

A secondary focus of the strategic plan is to provide Institutional support for the methodological platforms required to enable health research. These will build on and expand currently available infrastructure across the U of T Medicine/TAHSN community.

Strategic Priorities

1) Human Development

An emerging area of health and biomedical science focuses on defining environmental influences that foster both healthy fetal and neonatal development and predispose individuals to enter specific disease trajectories. Recent evidence indicates that exposure to adverse conditions in the antenatal period (e.g. inadequate maternal nutrition), and during infancy and childhood results in increased risk of neuro-cognitive and cardio-metabolic illness, impaired learning and limited ability to engage in successful social integration. Research in the field of epigenetics indicates that the mechanisms causing these developmental trajectories rests, at least in part, on interactions between genes and the environment in early life. Alarmingly, the number of children world-wide affected by these adverse outcomes is increasing, and threatens to overwhelm health, education and social service systems.

In response to these highly complex health challenges, a U of T Medicine/TAHSN wide multidisciplinary initiative, the Institute of Human Development (IHD), has been established. U of T Medicine along with OISE/UT are key participants in the Institute with two of the founding principal investigators located in the Departments of Physiology and Obstetrics and Gynaecology. The breadth of expertise in this area ranges across maternal-child health, learning, and development involving multiple academic units at all three U of T campuses and TAHSN. U of T Medicine alone has 288 researchers in the area of development/child/maternal health, involving every one of the U of T Medicine/TAHSN sites. In 2009-10 these researchers brought in $18.0 million in Tri-Council grants and $42.0 million in funding from health charities, foundations and provincial government sources.

The Institute will help to realize the potential of on-going large population-based studies including the Ontario Birth Cohort Study that includes genetic and epigenetic analysis of samples collected through early neonatal development and childhood. The effect of environmental factors such as nutrition and culture on developmental milestones, overall health (obesity, cognitive ability) and social awareness will be determined and the effect of selected interventions evaluated.

2) Global Health

Understanding the environmental characteristics that favor life-long human health in turn raises the question of how to enable equitable access to appropriate provision of health care resource. The principle of equity is at the heart of an emerging 21st Century ecosystem that is defining the discipline and practice of Global Health. The 2008 WHO Commission on the Social Determinants of Health defined health equity as the absence of systematic differences in health, both between and within countries.

Global Health is an academic priority for many Faculties and Schools at U of T and this common focus is coalescing within a new Institute of Global Health Equity and Innovation. U of T Medicine, through researchers in the Dalla Lana School of Public Health with the Departments of Family and Community Medicine, Medicine and Surgery, has taken the lead in the formation of the Institute. U of T Medicine has 120 researchers in the broadly defined area of Global Health, involving every one of the U of T Medicine/TAHSN sites, and in 2009-10 these researchers brought in $10.5 million in Tri-Council grants and $23.2 million in funding from health charities, foundations and provincial government sources.

The breadth of research in Global Health includes projects examining the impact of climate change, infectious diseases, chronic disease management, urban and rural community design and resilience in the face of increasing community-wide challenges. Ongoing research ranges from examining how climate change affects complex interlocking systems

including: food production, urban design, and health care systems, to assessing the burden of infectious and non-communicable diseases on vulnerable populations. The requirement to provide vulnerable populations with affordable solutions, either technological or pharmaceutical in nature has led to the expansion of "frugal innovation" with an increased emphasis on prevention strategies.

3) Neurosciences & Brain Health

Brain Health is a key component of Human Development and Global Health, the increasing incidence of autism in children and mental health challenges at all ages are examples that underscore the need to understand the biology and sociology of Neurosciences and Brain Health. The U of T and TAHSN are home to one of the greatest concentrations of neuroscientists in the world. U of T Medicine alone has 475 researchers and their teams in the area, who collectively brought in $30.1 million in Tri-Council and $63.0 million in funding from health charities, foundations and provincial government sources in 2009-10.

Neuroscience and brain health represents an enormously complex and diverse research and health care sector that focuses on how the biological determinants of the central and peripheral nervous systems interplay with social and environmental determinants to effect human behaviour and health. Research ranges from birth cohorts examining how early development affects cognition and the ability to learn, through traumatic injury to the spinal cord and the brain, to addiction and mental illness, and the consequences of aging and neural degeneration in Alzheimer's and Parkinson's diseases.

A virtual Institute for Neurosciences and Brain Health is envisioned that will bring together topic-specific clusters, such as the Toronto Dementia Research Alliance and the Tanz Centre for Neurodegenerative Disease, that cross disciplines and Faculties to address the fundamental challenges of development, regeneration and degeneration of neuronal networks. Researchers in the Institute will combine neuroimaging, epigenetics, high-throughput genomics/proteomics/metabolomics screening, systems biology and epidemiology to address these complex problems.

4) Complex Disorders – System Management

Advances in Human Development revealing predisposition to chronic disease trajectories, recognition that non-communicable diseases including mental health and cognitive disorders are now the most prevalent health challenges globally, U of T Medicine will focus on the systems management of the most common complex disorders affecting Canadians. Successfully addressing these challenges will require system-wide solutions in the understanding and management of the interplay between health promotion and disease

treatment. Equitable access and effective management of concurrent disorders, e.g., individuals who suffer Parkinson's disease and simultaneous depression and cardiovascular disease, require integration of medical/ rehabilitation /pharmaceutical / social care delivery and fundamental health and biomedical research.

U of T Medicine/TAHSN is one of the few academic communities with the breadth and depth of health researchers required to effectively tackle these complex problems. For example, within U of T Medicine there are at least 1,500 researchers in this overall area with in excess of $400 million in funding in 2009-10, covering the Thematic Areas of Cancer, Clinical Research (includes Rehabilitation, Primary Health Care), Cardiovascular, Drug-Development/Toxicology, Infection/Immunology Inflammation, Metabolism & Nutrition, and Health Services/Health Policy. These researchers are distributed across a number of U of T Medicine's Centers and Institutes (extra-departmental units - EDUs) focused on addressing their individual section of the problem; including the Banting and Best Diabetes Centre, the Lewar Heart & Stroke Centre for Cardiovascular Research, the Transplantation Institute, Musculo-skeletal Centre and the Centre for Patient Safety. To provide system-wide solutions requires effective interaction among researchers in these EDUs to develop innovations that can be tested in the TAHSN and partner communities.

An example of U of T Medicine/TAHSN addressing a common challenge in health care is the development of an innovative solution focused on reducing hospital admissions. Researchers and clinicians in the U of T Medicine Departments of Family & Community Medicine and Medicine have established a new patient-centred Virtual Ward "The Bridges program" focused on enabling effective ambulatory and community-based care and reducing hospital re-admissions through the provision of inter-professional team support and establishment of most responsible primary care physician oversight. Evaluation of the effectiveness and impact of this intervention will contribute to transformation of health systems locally and nationally. This intersection of quality improvement, knowledge translation and health systems design represent a new inter-disciplinary approach to solving complex challenges in health care provision.

Strategic Infrastructure Platforms

The successful implementation of the Strategic Priorities outlined above require the availability of highly sophisticated core research infrastructure ranging from integrated health informatics, through high resolution/high throughput imaging and screening methodologies to effective dissemination/commercialization strategies. In many cases individual research groups have developed customized solutions to methodological challenges, however these are not integrated (for example genomics data are not integrated across the different disease-specific research groups). To enable effective use of

infrastructure resources and dissemination of best practices the UofT Medicine and TAHSN research institutes will conduct an environmental scan to determine current strengths and identify areas for development.

a) Health and Bio-Informatics Cluster

This cluster will bring together leaders in the collection and use of health related electronic data to enable research in basic, clinical, population and public health. All of these fields are experiencing an unprecedented and exponential increase in information such that our collective task is to turn the individual data streams into relevant knowledge. The U of T Medicine/TAHSN group is not unique in this need and many institutions have implemented integrating programs such as the Biomedical and Health Informatics program at the University of Washington (http://www.bhi.washington.edu/vision) linked to the US-wide American Medical Informatics Association (http://www.amia.org/). The intent is to enable research in and implementation of informatics across the full spectrum of research from analysis and interpretation of genomic/epigenomic/proteomic data, to evaluating the impact of personalized medicine on the health of communities.

b) Integrated Functional Imaging Cluster

The cluster will bring together imaging researchers and infrastructure from molecular (NMR X-ray diffraction) through single cell and tissue (electron & transmission/confocal microscopy) to whole body (PET, MRI). U of T Medicine/TAHSN are world leaders in functional imaging and the program will unite basic and clinical researchers with physicists and chemists to expand and diversify the implementation of imaging in the study of health and disease.

c) Knowledge Exchange/Translation and Commercialization

In the area of Knowledge Exchange the Wilson Centre for Educational Research and the Li Ka Shing Knowledge Institute focus on how to expand and improve our abilities to transfer new knowledge outside the circle of discovery. In the commercialization sphere MaRS Innovation will continue to take the most promising breakthroughs from U of T Medicine/TAHSN institutes, and commercialize them, in addition to this venture we will be expanding the training and opportunities for individual faculty to be involved.

Next Steps - Implementation Planning and Tactics

The above strategic priorities and intention to establish the infrastructure platforms, will guide the next steps in developing a specific implementation plan including tactics to enable successful. The Faculty of Medicine under the guidance of the Vice Dean Research and International Relations will work closely with Department Chairs and Vice Presidents Research from the fully-affiliated hospitals to identify tactics and feasible milestones. An Implementation Planning document will be prepared no later than mid-2012. Key performance indicators will be used to measure outcomes and impact. Importantly, the Research Strategic Plan and its implementation tactics fully integrate with and give specific direction to the U of T Medicine Strategic Academic Plan 2011-16.

Performance Indicators for Research

The success of the strategic plan requires evaluation of specific indicators, some of these are standard and information is currently being collected by Department/EDUs/Research Institutes, other areas will require development new metrics. These will be developed and collected in partnership with the TAHSN community.

Standard Metrics

- Core facilities/Space
- Grant/Contract Funding
- Clinical Trials activity
- Publications/Citations/Journal Impact
- Conference presentations and invited lectures
- Conferences organized
- Student & Faculty scholarships/fellowships (includes Endowed Chairs, CRCs)
- Student & Faculty honors
- Number of graduate students/PDF and destination (Academia/Industry/Health Care)
- Education innovation
- IP/Disclosures/Royalties/Spin-off companies

Non-standard Metrics

- Interaction with Media/Government (Provincial & Federal)
- Uptake & implementation of new Policies/Methodologies
- Economic Impact (will develop new measures)
- Participation in National and International Policy-setting Bodies
- Surveys of student/staff/faculty satisfaction/effectiveness
- Collaboration and outreach within and outside U of T Medicine/TAHSN

Clustered Areas of Emphasis

Bio-Engineering/Technology Development
Biomaterials | Nanotechnology | Innovation

Cancer
Neoplasia | Cancer-immunology | Retina-oncology | Gynaecologic-oncology | Cancer-biology

Cardiovascular
Ablation | Embolization | Heart | Cardiovascular Pharmacology | Hematology

Computational Biology
Bioinformatics | Biological Networks | Computational networks

Clinical Research
Cataract surgery | Clinical Pharmacology | Clinical Trials | Critical care | Dermatology | Emergency Medicine | Forensic Science Medicine | Gastroenterology | General internal medicine | General Surgery | Geriatrics | Glaucoma | Intensive care | Mechanisms of organ dysfunction | Movement Science | Nephrology | Oculoplastics | Oral dynamics | Oral pathology | Physiatry | Primary Health Care | Pulmonary | Rehabilitation health services | Renal Pathology | Respirology | Trauma Emergency Transplantation | Upper Airways| Urogynaecology | Voice

Development/Child/Maternal Health
Child language | Child psychiatry | Cystic fibrosis | Development| Developmental immunology | Infants | Infant health | Pediatrics | Pediatric-Adolescent gynaecology | Pediatric ophthalmology | Reproductive health | Women's Health (reproductive)

Education/Knowledge Translation
Faculty Development | Knowledge Transfer/Translation | Education

Genetics Genomics-Proteomics
Chemical Genomics | Clinical Genomics | Functional Genomics | Genetics | Gene expression and development | Genetics of development | Model organism genetics | Molecular medicine | Proteomics

Health Services/Health Policy
Advancing Practice | Bioethics | Child Health Evaluative Sciences | Comparative Health systems |Evaluation of care | Health economics | Patient safety |Performance management | Public Health Policy | Quality improvement | System design

Imaging
Imaging technology development | Ischemia imaging | Medical physics | Molecular imaging | Perfusion | Ultrasonography

Immunity/Inflammation/Infection
Adaptive immunity | Autoimmunity | Immunodeficiency | Immunopharmacology | Innate immunity | Infectious disease | Microbiology | Virology

Metabolism/Nutrition
Diabetes | Endocrinology | Metabolism | Nutrition

Musculoskeletal
Bone Health | Rheumatology

Molecular Cell Biology
Biomolecular structure and function | Cellular biomolecular | Interdisciplinary Cell Biology | Membranes and Transport | Molecular biology | Molecular structure and function | Protein folding | Receptor pharmacology | Signal transduction| Systems biology

Neuroscience and Brain Health
Anxiety disorders | Anesthesia |Audiology | Behavioural health science | Cornea and external disease | Dementia | Drug addiction | Healthy relationships | Language studies | Mental health | Mood | Neural | Neurobiology | Neurology | Neuro-opthalmology | Neurodegenerative diseases | Neuro-pharmacology | Neurophysiology | Neuro-rehabilitation | Pain | Psychotherapy | Psychiatry | Schizophrenia | Sensory systems | Sleep medicine | Social behavioural health | Speech fluency and production | Suicide studies | Swallowing

Drug Development/Toxicology
Behavioural pharmacology | Drug metabolism | Models of disease | Molecular toxicology | Pharmacogenetics | Pharmcokinetics

Population Health/Global Health
Clinical outcomes | Culture and Community health | Diversity and Inclusion | Epidemiology | Environment and Health | Enhancing participation| Observational and decision sciences | Occupational and Environmental Health | Health Promotion/Disease Prevention | Veterans

Regenerative Medicine
Stem cell biology | Tissue engineering