Basic science funding in Canada: a threat to McGill that needs a university response

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Anyone doing research at McGill University understands that we have reached a critical juncture in the idea of curiosity-driven research. The drive and desire to understand things for their own sake is being altered, shaped and pushed toward the application of such discoveries. What we write about below stems out of conversations with our colleague Dan Bernard and questions that he and I have asked at Senate. Although it applies most directly to biomedical research, the concerns in other areas of academic inquiry are similar.

Critical to an understanding of disease and to the development of new therapies and preventive measures, basic biomedical science is deeply rooted in the history and success of modern medicine. One can point to a number of historical successes in the translation of basic science discoveries into clinical applications- antibiotics, the use of jellyfish fluorescent proteins like GFP in numerous cell and tissue imaging applications, RNAi, nanotechnology and stem cell-based therapies. The need for continued curiosity-driven research is essential to future discoveries as well. Who knows, for example where the combination of stem cell research and genome editing technologies such as CRISPR will take us in terms of gene therapy, diagnostics and core understanding of numerous diseases. Further, the technological revolutions in drug screening, genomics, proteomics and all the new "omics" areas has fundamentally transformed the quality, nature and quantity of data basic scientists can generate and analyse. Paradoxically, these tools have revealed huge gaps in our understanding of how things work at the molecular level that will require years of additional work. Paraphrasing Donald Rumsfeld- "there are known unknowns and unknown unknowns". Biology is rife with both at present. This should be an exciting time for researchers and students! However, the push to apply discovery not only interferes with a desire to understand, it also means we end up applying our discoveries too early. Here, we would like to explore several problems associated with the push to apply research.

The generation of new knowledge is in short shrift in the current funding scheme.

In order to create a knowledge-based society, a steady supply of new knowledge is required. There are numerous examples in the history of science that the major breakthroughs and fundamental discoveries originated from basic research, defined as systematic study directed toward a fuller understanding of the fundamental aspects of phenomena and of observable facts without specific applications in mind (www.sciencemag.org 3 August 2012). The majority of Nobel Prizes in sciences have also been awarded for the results of this kind of research. Invariably, such research was driven by curiosity and the desire to understand rather than by the priorities of the funding agencies, directives of the government of the day or interests of the private sector.

The prevailing direction of the recent funding of biomedical research in Canada (see: http://www.nature.com/news/canadian-election-spotlights-scientists-frustrations-1.18381) as well as the allocation of the new funds in the recent federal budget clearly underemphasizes curiosity-driven basic research at the expense of mission-oriented, translational and applied research. Considering that tomorrow's progress in therapeutic and preventive interventions critically depends on basic research discoveries of today, this funding strategy is highly problematic.

The parliamentarians, bureaucrats, university administration and the general public need to know that the private sector, requiring a rapid return on investment, will not fund this research because it is unpredictable and the benefits can be delayed.

As the NIH director Francis Collins wrote, "When everybody gets to one side of the boat, it usually tips over." (http://www.sciencemag.org/content/337/6094/503.summary). This metaphor may be instructive to

strategists behind changes in Canadian biomedical research by reminding them that the balanced investment in all components of the research continuum is essential for future progress.

Thus, it is imperative to recognize explicitly that generation of new knowledge *per se* is a scientifically meritorious activity and to provide support and funding of the investigator initiated, curiosity driven basic research.

The imbalance between funding for infrastructure/recruitment compared to funding for operating expenses.

As mentioned above, the stated goal of both federal and provincial governments is to create a knowledge-based society. Toward that end, the federal government funds initiatives to recruit and retain the best scientists and academics through programs such as the Canada Research Chairs (CRC, www.chairs-chaires.gc.ca), the Canada Excellence Research Chairs (CERC, www.cerc.gc.ca/), and the Canada Foundation for Innovation (CFI, www.innovation.ca). The CRC program stands at the center of a national strategy to make Canada one of the world's top countries in research and development, investing $300 million per year to attract and retain the world's most accomplished and promising minds. The CERC Program awards world-class researchers up to $10 million over seven years to establish ambitious research programs at Canadian universities. The infrastructure funded by the CFI includes the state-of-the-art equipment, laboratories, databases, specimens, scientific collections, computer hardware and software, communications linkages, and buildings necessary to conduct leading-edge research. To date, CFI has invested $6,613,617,476 in Canadian research (see: www.innovation.ca/en/OurInvestments/ProjectsFunded/SummaryProjectsFunded).

After researchers are recruited and their labs are built, renovated or refurbished, and their equipment is purchased, they need to actually go about doing the business of science. This involves hiring and training staff (research assistants, technicians, postdoctoral fellows and students) and purchasing chemicals, glassware, tools, and services. These activities are funded by the Canadian Institutes of Health Research (CIHR, www.cihr-irsc.gc.ca), the Natural Sciences and Engineering Research Council (NSERC, www.nserc-crsng.ca), and the Social Sciences and Humanities Research Council (SSHRC, www.sshrc-crsh.gc.ca). In contrast to the newer funding programs mentioned above, funding for CIHR, NSERC, and SSHRC has not increased to keep pace with the growing number of researchers and their state-of-the-art laboratories. Without balance between these two types of funding programs, research in Canada remains significantly underfunded- like a race car without fuel or a new home without electricity or running water.

CFI funds new equipment and not replacements for core equipment.

This growing disparity between funding for laboratory creation and laboratory operation must be addressed. Otherwise, we run the real and serious of risk losing the talent so many resources were used to recruit, leaving their labs empty and their equipment unused.

The CIHR Foundation Scheme

CIHR recently underwent a massive change in how it funds research- switching from face-to-face peer review to a virtual review system. Further, instead of its traditional open operating grant program, it is now piloting massive changes to funding programs, essentially ignoring concerns raised about it across the country. Here again, in a recently released strategic plan, basic research is barely mentioned (http://www.cihr-irsc.gc.ca/e/39977.html). It is difficult to apply discoveries that never get made!

The results of the 1st live pilot of the new CIHR Foundation funding scheme as well as the last open operating grants program were announced in mid-July 2015. These results are further cause for alarm. Only 120 of the 1366 Stage 1 applicants in the Foundation scheme were ultimately funded (<9%). New investigators were particularly disenfranchised, though investigators at all career stages reported significant problems with the new and untested online review process. Indeed, a review of both 'winners and losers' reveals many surprises at McGill and elsewhere. In addition, though CIHR committed to funding 450-600 tOOGP proposals, only 383 grants were awarded and each endured a budget cut of almost 30%. Unfortunately, these numbers cannot be

construed as anomalies associated with the transition to new funding schemes (i.e., bumps in the road). Calculations based on CIHR projections (since taken down from their website) suggest that, annually, the number of project and foundation grants will be 300-500 and 120, respectively. This is down from more than 800 grants funded per year in the previous system. We can also anticipate that the large across the board budget cuts will continue. In addition, CIHR cancelled funding of its MD-PhD program. At the provincial level, the FRQNT cancelled several programs this year and clawed back 20% of the direct costs on existing grants. It is not hyperbole to suggest that we will soon reach a crisis if current trends continue. Our undergraduate and graduate students can see the writing on the wall too and are moving away from academia as careers.

The lack of indirect funding from CIHR

When companies fund research at universities through contracts, they usual pay both the direct costs (i.e. those associated with the actual conduct of the research itself), as well as the indirect costs associated with that research. Indirect costs are often referred to as F&A or facilities and administration. Thus, they include the costs of running and maintaining research spaces (e.g., heat, electricity, cleaning) as well as the costs associated with the administration of research funds (e.g., financial management, compliance with federal guidelines on animal use, biohazards, radioactivity etc.). Indirect costs also provide funds for core services such as libraries and online resources (e.g., journals and databases). Industry funding of indirect costs is 40% of the total value of the direct costs. So, for every $100K of direct costs, industry pays an additional $40K for F&A. This is actually on the low end of the spectrum, and assumes that any intellectual property generated will be shared between the university and the corporate sponsor of the research. If the companies plan to keep the IP, the indirect costs paid usually increase significantly. In the USA, the NIH (equivalent to CIHR in Canada) pays between varying rates depending on the institution of the indirect costs associated with research; these rates are in the 55-70% range. For example, at the University of Michigan, the rate is 55.5% (http://orsp.umich.edu/proposals/budgets/indirect_cost_rates.html), at Johns Hopkins University it is 62% (http://www.hopkinsmedicine.org/Research/ora/handbook/appendixc.html) and at Harvard it is 69.5 (http://osp.fad.harvard.edu/content/fa-cost-rates-federal-sponsors). At CIHR, NSERC, and SSHRC, it is only 20%.

Indirect costs allow universities to physically sustain research activities that are not funded by the education ministries in different Canadian provinces. This is not sustainable, as more and more researchers are recruited and research space grows. Combined with a similar deficit in provincial funding for educational spaces, the problem will become critical in a very short time, and will lead to a serious degradation in our ability to train students and retain strong academic personnel.

The idea that the federal government will in future support industry directly and academic research indirectly.

This seems wrong-headed for several reasons. First, it will not be cost efficient as university research lead by individual academic investigators has been shown to be more efficient with regard to job creation and money invested in scientific and academic research. Second, most research is peer-reviewed (i.e. vetted by other experts for its value and feasibility) and this component risks being lost entirely in an industry-driven research agenda. Thirdly, innovation will be stifled. Companies (and even CIHR now) are generally conservative and risk-averse. University-based research, in principle, is much more open to new possibilities and new research directions. It would be dangerous to have all research driven by bottom-line economic considerations alone. Yes, we live in the real world but research should be a balance between goal-driven and curiosity-driven aims.

A made at McGill solution?

Funding problems are not unique to the Canadian context. Indeed, one can see parallels, for example, in the US, where the NIH budget has been flat for more than a decade. An important difference, however, is the concerted effort among American investigators, institutions, non-profit organizations, and private citizens to challenge lawmakers and funding agencies to turn the ship around. For example, recently the University of Wisconsin-Madison, a leading public research-intensive university, initiated an inter-disciplinary dialogue about strategies to rescue biomedical research in the US see: http://elifesciences.org/content/4/e09305).

Though we can benefit from greatly from the products of their discussions, we need a set of made at McGill and made in Canada solutions. As one of Canada's most prestigious universities, should McGill be taking a leadership role in driving discussions about the trajectory of research funding in Canada? If so, how would the University define this role and what steps is it prepared to take to enact it? Even if McGill spearheads or contributes to efforts to alter current funding trends, it will take years to turn things around. Therefore, what are the universities' short- and long-term plans to address the impacts of funding decreases on its overall research mission, its capacity to train the next generation of researchers, and the ability of its research faculty to pursue their academic careers? These are some of the questions all McGill's researchers might want answers to.