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U15 Fundamental Science Review Submission

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U15

Group of Canadian Research Universities
Regroupement des universités de recherche du Canada

Introduction

The U15 Group of Research Universities is encouraged by the panel's mandate to ensure that federal support for Canada's research excellence is both strategic and effective. Fundamental, discovery-driven research is a central component of our innovation ecosystem, opening new frontiers and creating new opportunities. Canada is home to world-class researchers, and it is our responsibility to create the conditions that enable these talented Canadian researchers to both contribute to and drive ground-breaking, world-class research. Facilitating this critical fundamental research and building capacity for knowledge transfer will help increase the impact of discovery-driven research.

Fundamental research lies at the core of advances in innovation, and is the foundation of any innovation ecosystem. Ensuring that Canada has globally competitive funding for our world-class fundamental research is a U15 priority.

Competitive funding for fundamental research is necessary to establish the best possible conditions for innovation. Competitive funding alone, however, is not sufficient to create these conditions. To ensure that our innovation ecosystem is best poised to thrive, we need a system consisting of entrepreneurial companies and funders, as well as competitive funding for universities to build pipelines and systems for knowledge transfer. A comprehensive and robust innovation ecosystem will, of necessity, draw on the natural sciences, the social sciences and the humanities, life sciences, engineering, and the healthcare and biomedical sciences to develop and adopt new technologies and to realize their full economic and social benefit.

Canada's research funding system has a strong foundation in the Tri-Council and the Canada Foundation for Innovation (CFI). This fundamental science review offers the opportunity to establish key principles for advancing science and research in Canada, and to ensure that the Tri-Council and CFI are organized around these key principles. Focusing on principles in science funding will lead to a range of significant changes that could greatly improve efficacy within the existing Tri-Council and CFI structure.

We encourage the panel to draw on its extensive expertise to identify strategic objectives for Canadian scientific research, and to propose recommendations that will help us achieve these objectives.

In order to position Canada ideally to achieve research excellence, our research funding ecosystem must be based on the following principles:

- **Strategic.** Canada's funding ecosystem must be properly equipped to identify and capitalize on longer-term opportunities;

- **Simple.** Unnecessary complexity in granting agencies, programs, applications and grant administration leads to silos that hinder collaboration and interdisciplinarity and increase administrative burden;

- **Flexible.** Canada's funding ecosystem must be able to support rapidly-emerging opportunities and ensure that researchers do not miss out on potential collaborations or research opportunities; and

- **Ambitious**. Focusing on long-term, risky scientific endeavours that build on our current and emerging research strengths is the best way to use science to advance national objectives, address future challenges, and maintain and improve our standing in the international research community.

The international research landscape is evolving; Canada's research funding system must also evolve to address these changes. Building on the foundation of strong, investigator-initiated disciplinary research, science has become increasingly collaborative. It is no longer confined within a country's border or a single discipline. In order to ensure that Canada's researchers and our research infrastructure are able to maintain leading roles in advancing global science, our research funding ecosystem must be designed and financed at levels that allow our researchers and research institutes to capitalize on the collaborative, interdisciplinary, international nature of today's – and tomorrow's – ground-breaking science.

Targeting funding to support the fundamentals of science will enhance our capacity to undertake ground-breaking, world-class research and to foster important partnerships with the public, private and non-profit sectors, as well as with international researchers and institutes. Our research funding system should support:

- **People**. Scholarships, fellowships, and chairs.
- **Research**. The full cost of research projects, including materials, equipment, technologies, salaries, operating and administrative costs.
- **Infrastructure**. World-class equipment to ensure that Canadian institutions will be world-class research sites, while continuing to fund strategic national infrastructure as well as gaining access to international research infrastructure through strategic investments.

Building on the Haldane Principle, which holds that decisions regarding research funding are best made by research experts, rather than politicians, The U15 suggests that the federal government create a standing arms-length expert panel to advise the government to ensure that our programs continuously evolve to create the best conditions for research excellence. This process will include regular, rigorous assessments of our funding programs, including Canada Research Chairs and Canada Excellence Research Chairs, to ensure that they meet objectives and advance research excellence.

This panel should include international and domestic experts, and could be included in the Science, Technology and Innovation Council's (STIC) mandate, the Chief Science Officer's mandate, or be convened as a part of a new initiative. This panel will be referenced throughout this document.

The U15 is confident that the Fundamental Science Review Panel is well-positioned to assess the current state of scientific research in Canada rigorously, while developing innovative and necessary solutions to the barriers that hinder Canadian advancement in research excellence. The following responses address the mandate questions released on June 13, 2016:

1) Are there any overall program gaps in Canada's fundamental research funding ecosystem that need to be addressed?

The Canadian research landscape is evolving at a rapid pace. The changes are interconnected, and reflect an international shift in scientific research. Research is increasingly collaborative, and is no longer confined by borders or disciplines. In order to ensure that Canada's researchers and our research infrastructure are able to maintain leading roles in global science, it is crucial that our research funding ecosystem evolves to capitalize on the collaborative, interdisciplinary, international nature of today's – and tomorrow's – ground-breaking science. There are many benefits for Canada from being a global research leader, including ensuring that we are integrated into global knowledge flows, identifying and fostering important partnerships, engaging in science diplomacy and improving our international reputation.

Canada's fundamental research funding ecosystem will be best-positioned to capitalize on its strong foundations through reflective assessments. Undertaking regular comprehensive, forward-looking reviews led by arms-length expert panels will ensure that our programs continuously evolve to create the best conditions for research excellence. These panels should focus on the following principles:

- **Strategic**. Canada's funding ecosystem must be properly equipped to identify longer-term opportunities;
- **Simple**. Unnecessary complexity in granting agencies, programs, applications and grant administration leads to silos that hinder collaboration and interdisciplinarity and increase administrative burden;
- **Flexible**. Canada's funding ecosystem must support rapidly-emerging opportunities and ensure that researchers do not miss out on potential collaborations or research opportunities.

Building on the principles of strategic, simplified and flexible funding, there are also specific program-level gaps:

- Funding for the full cost of research;
- The capacity to fund international research collaborations efficiently, particularly when opportunities arise outside of granting cycle timelines;
- Appropriate adjudication and funding for interdisciplinary research and support for the interdisciplinary nature of the research environment;
- Further mechanisms to fund scaling up. The Canada First Research Excellence Fund (CFREF) is a good example of providing support for scaling institutional strengths into world-class capabilities but should further value and support national collaboration;
- Funding for capacity to foster success in emerging fields and by new scholars; and
- Support for high-risk, long-term research that may not fit into current program schemes or funding cycles.

2) Are there elements or programming features in other countries that could provide a useful example for the Government of Canada in addressing these gaps?

There are international practices and examples that seek to address a range of program gaps in our research infrastructure that could inform a review of Canada's research ecosystem.

Some international funding bodies have prioritized coordination of funding:

- **Germany**'s Max Planck Society, Fraunhofer Institute, Leibniz Association and Helmholtz Association have well-integrated coordination across many research areas and fields, differentiated by technological readiness rather than discipline; and
- In the **UK**, Sir Paul Nurse's Report "Ensuring a successful UK research endeavour" recommends increased coordination of various parts of the research landscape, as well as simplified operational policies. The government has indicated that it will implement Nurse's recommendations.

While Canada has made significant investments to advance research excellence, including the Canada First Research Excellence Fund, international funding programs have also focused on fostering domestic strengths on the world stage:

- **Germany**'s Excellence Initiative is a federal program through the DFG to fund graduate schools, clusters of excellence and institutional strategies. Funding is available to universities with a graduate school and a cluster of excellence.
- The **Danish** National Research Foundation funds Centres of Excellence, with the objective of promoting world-class research in universities. The centres strengthen institutions' strategic efforts to prioritize research and create a distinct research profile, much like the Canada First Research Excellence Fund. This also serves to simplify the funding system and reduce the administrative burden.
- **France**'s Investments for the Future Program focuses on international recognition of education, research and innovation clusters, with results-oriented practices. The program's explicit objective is to prepare France for the challenges of tomorrow through investments in clusters that include higher education and training, research, industry and SMEs, sustainable development and digitization. These clusters consist of universities, governmental organizations, industry and national institutes, all recognized for their excellence in key, complementary fields.

Other international funding bodies have developed assessment processes to fund big science:

- Several international funders (including the National Science Foundation in the **United States**, the Commonwealth Scientific and Industrial Research Organisation in **Australia** and the Research Council in the **UK**) have engineered full-cost funding systems for big science. They fund large-scale facilities typically assessed through comprehensive funding proposals that include:

    - the initial capital costs for construction;
    - the costs for commissioning;
    - the operating and maintenance costs;
    - the plan for capital upgrades; and
    - decommissioning plans.

Other funding bodies have also developed systems to ensure that the full cost of research, including indirect costs, is funded:

- In the **United States**, federal granting agencies reimburse indirect costs at a pre-negotiated rate that varies by institution. The funding formula is highly complex but typically ranges from 50 percent to 60 percent;
- **Australia** provides block grants for operating costs based on a time allocation survey of researchers. Funding for indirect costs under this program varies from 30 percent to 90 percent.

Some nations have used block grants to allow research institutes to identify their own priorities and funding break-downs.

- **Australia** has instituted research block grants, through which universities receive a substantial grant to administer within broad guidelines, in order to reduce the administrative burden and shift the onus of responsibility of delegating the funds to the institutions.
- The **UK** has implemented the Research Excellence Framework (REF), a system for assessing British post-secondary education institutes. The system produces indicators of research excellence for benchmarking purposes, enabling it to distribute funding by reducing the administrative burden. The Russell Group in the UK supports the operational efficiency of these grants, but warns that the academic community must determine research priorities, in conjunction with key stakeholders and user groups, and worries that these block grants could undermine the peer review process.

Funding of Fundamental Research

1) Are granting councils optimally structured and aligned to meet the needs of the current research community in Canada? Are the current programs the most effective means of delivering the objectives of these organizations? And are they keeping pace internationally? The review should take into account the several reviews and evaluations that were performed in recent years on the councils and on science and scholarly inquiry in Canada.

As the research landscape becomes increasingly collaborative, interdisciplinary and international, funding from the granting councils becomes most effective when it improves the conditions for this type of research and fosters partnerships with private, public and non-profit sectors, as well as with international academics. The U15 maintains that funding for fundamental science should support these pillars in order to foster the collaboration, interdisciplinarity and cross-border research that drives the current science landscape:

- **People**. Scholarships, fellowships, and chairs.
- **Research**. The full cost of research projects, including materials, technologies, salaries, operating costs, and administration;
- **Infrastructure**. World-class equipment to ensure that Canada will be a research driver as well as funding that enables Canadian researchers to access international research infrastructure.

Building on these three basic pillars of support for research will foster excellence, establishing Canada as a world leader in science research. There are also specific programs that could

further support Canadian researchers in the new research landscape, provided that they are **strategic**, **flexible**, and **simple**:

- Our research funding ecosystem must be sufficiently flexible to reflect the fact that the cost breakdown can vary substantially from project to project. A single, comprehensive application outlining all anticipated research costs can help to achieve a balance in research funding, while ensuring that the full cost of research is funded. Infrastructure funding provided through the John R. Evans Leaders Fund from CFI is one example of how a single application can be used to support research while reducing applicant and reviewer workloads.
- Our funding process must be able to fund high-risk, long-term research deemed relevant to our national interests and to the fundamental pursuit of knowledge, while remaining cognizant of the fact that it may take longer than a single granting cycle to generate publishable, world-class work.
- A mechanism to allow for funding adjudications that take place outside of the traditional granting cycle will facilitate and improve Canadian participation in international collaborations on research and infrastructure projects.
- Funding must support the full lifecycle of a project, as best the application can anticipate that lifecycle.

2) **Are students, trainees and emerging researchers, including those from diverse backgrounds, facing unique barriers within the current system and, if so, what can be done to address those barriers?**

A diversity of perspectives and approaches enhances research excellence. Likewise, Canada's research ecosystem is strengthened by having a wide range of research and researchers who explore big questions in fundamental science. Canada's academic system has faced chronic challenges in ensuring adequate representation of certain groups, notably women, Indigenous scholars, visible minorities and persons with disabilities. The factors hindering members of these groups from entering the academy vary. It is imperative that our funding system foster a research and education environment where researchers from diverse backgrounds thrive.

The U15 has identified some barriers hindering trainees and emerging researchers, including those from diverse backgrounds from entering into the academy. These include:

- Dynamics in the hiring practices at Canadian universities, which delay the hiring of early-career researchers:
    - The end of mandatory retirement, coupled with the economic climate, has resulted in fewer retirements, and as a result, fewer new academic hires; and
    - Increased tendency toward sessional appointments, which may limit the capacity of young researchers to undertake the research they have been trained to do;
- Mid-career funding decline, leading to:
    - Termination of long-term projects;
    - An inability to fund graduate students or post-docs (tomorrow's researchers); and
    - The closure of labs;

- Lack of mentorship programs to encourage those historically excluded from university research to pursue academic endeavours; and
- Emphasis and funding priority accorded to areas where researchers from diverse backgrounds are under-represented, and to theoretical frameworks that do not reflect diversity of experience (including, but not limited to, traditional knowledge, feminist theory, diasporic theory, critical race theory, and social justice theories).

The following opportunities could facilitate pathways to research for those scholars with diverse backgrounds:

- Encourage scientific curiosity from an early age, particularly among groups under-represented in the academy;

- Establish mentorship programs for tomorrow's researchers;

- Ensure appropriate supports exist for our scientific researchers over the course of their entire career, including bridging funding should changes be made to the current funding structure; Acknowledge that diverse perspectives and methodologies improve the capacity for scientific study and enhance research processes and outcomes; and

- Support a range of academic career trajectories that take into consideration familial responsibilities and other external challenges while encouraging professional development opportunities that acknowledge these realities.

Several international programs that aim to improve opportunities for under-represented groups may inform a Canadian approach:

- **Germany**. After identifying a projected shortcoming of research scientists in Germany, International Max Planck Research Schools (IMPRS) sought to encourage international students to come to Germany for a PhD. The IMPRS offers a post-doc position that allows these young researchers to become the head of an "Independent Junior Research Group" at a Max Planck Institute, and provides them with five years to pursue their own research on a limited but secure budget.

- **Germany**: Max Planck Society's Minerva Project seeks to attract female scientists, offering mentoring programs, advanced training seminars and childcare, with the aim of qualifying women in the programs for research leadership positions. This program is credited with doubling the percentage of women among Max Planck scientists.

- The **UK**'s Athena SWAN Charter and **Australia**'s Science in Australia Gender Equity (SAGE) are accreditation programs built around basic principles, and focusing on advancing women's careers in STEM.

3) Is there an appropriate balance between funding elements across the research system, i.e. between elements involving people and other direct research costs, operating costs, infrastructure and indirect costs? What are best practices for assessing and adjusting balances over time?

In order to ensure a balance in research funding, funding should be targeted to support **people**, **research** and **infrastructure**. The U15 has identified some potential tools for achieving a balance in research funding:

- A single, comprehensive application process. Our research funding ecosystem must be sufficiently flexible to reflect the fact that the cost breakdown can vary substantially from project to project. A single, comprehensive application outlining all anticipated research costs can help to achieve a balance in research funding, while ensuring that the full cost of research is funded.
- A reasonable threshold for materiality. This threshold would reduce unnecessary audits and researcher hours directed to unnecessary administrative work identifying and costing immaterial research resources.
- Block grants to cover indirect costs. The Research Support Fund provides support for indirect costs based on a funding formula that allocates funds to institutions at funding levels as low as 18 percent for Canada's largest research performers. CFI's Infrastructure Operating Fund provides support for maintenance and operations, with up to 30 percent of CFI funding allocated to this fund. This fund is directed to an institution, rather than a researcher. The benefit of this approach is that institutions can allocate the funding as needed, per the guidelines. This flexibility could serve as a model to reduce administrative burden and improve efficacy for other funding bodies, but it is important to note that the percentage of costs this fund supports does not always cover the full costs at hand.

4) Are existing review processes rigorous, fair and effective in supporting excellence across all disciplines? Are they rigorous, fair and effective in supporting riskier research and proposals in novel or emerging research areas or multidisciplinary/multinational areas?

Canada's granting councils have a strong record of robust peer review. Our funding bodies have balanced the need for transparency with due diligence, confidentiality, and expert assessment. The Haldane Principle states that research experts, not politicians, business leaders or non-experts are best-placed to make funding decisions.

The research community is engaged with the peer review process and committed to ensuring a robust system. Key points to consider to further strengthen the peer review system include:

- The peer review process must be rigorous, and the research community must perceive it as rigorous;
- The peer review process must be nimble and have the capacity to identify, pivot and fund emerging research;
- Any changes to the peer review process must be phased in gradually, allowing for assessments and necessary adjustments to avoid the funding disruption and community fallout that can arise from a sudden, systems-wide overhaul; and

- A single comprehensive application process could serve to reduce the administrative burden and reviewer fatigue.

The academy is well-suited to undertake long-term, risky scientific endeavours that build on our current and emerging research strengths. Doing so advances national objectives, addresses future challenges, and maintains and improves our standing in the international research community.

5) Are granting council programs and structures sufficiently flexible to reflect and accommodate the growing internationalization of research? Are granting council programs and structures accommodating the full range of research areas; multidisciplinary research; and new approaches ranging from traditional knowledge, including indigenous research, to more open, collaborative forms of research? If not, what steps could be taken?

International collaborations and the shared use of research infrastructure increasingly drive research. Our research funding model must facilitate and foster a collaborative research enterprise. There have been changes to granting council programs and processes to encourage international collaborations; however, these changes have been incremental rather than broad.

The U15 suggests the following program changes to ensure that our granting programs are sufficiently flexible to allow researchers to leverage important opportunities and drive world-class research projects:

- A flexible international research fund, reflecting the fact that collaborating on international research projects requires a capacity to leverage domestic funding on unpredictable timeframes;
- Increased portability of grants, to allow Canadian researchers to research abroad;
- Harmonized grants programs across disciplines, establishing discipline-specific programs only where harmonized programs leave specific needs unmet; and
- Broad coordination of international outreach by the Tri-Council. The U15 has heard from international partners that it is confusing to have *ad hoc* meetings with Tri-Council agencies that occur in siloes.

Funding of facilities/equipment

1) Is the Canada Foundation for Innovation optimally structured to meet the needs of the current research community in Canada? What are the strengths and weaknesses of the current model in delivering the objectives of this organization, including its ability to work complementarily with the granting councils? What is the appropriate federal role in supporting infrastructure operating costs and how effective are current mechanisms in fulfilling that role?

World-class research infrastructure is central to research excellence, providing our researchers and research institutes with the necessary tools to undertake ground-breaking research and foster rich partnerships. CFI's peer review process is arms-length and rigorous, effectively

providing important operations funding for key infrastructure. Some best practices from CFI that should be maintained include:

- The capacity to fund cross-council research;
- A structure that allows the foundation to work closely with the Tri-Council;
- Nimble responses that facilitate critical research opportunities, such as the Exceptional Opportunities Fund; and
- Reduced administrative burden for both the Tri-Council and institutions for operating and indirect costs through the Infrastructure Operating Fund which is administered by the institution as it sees fit. This leaves the onus of responsibility on the institution, with appropriate accountability.

There are also ways to improve the CFI's efficiency:

- The current CFI structure is effective, but mechanisms that allow for sustainable, predictable funding would improve it;

- The CFI's successful track record has led to increased responsibilities, including funding for digital research infrastructure and major science initiatives. It is important to ensure that CFI's mandate remains strategic and that the foundation is tasked with appropriate responsibilities;

- The requirements for provincial matching funds, particularly for national infrastructure, should be re-assessed; and

- The CFI only has observer status with regard to the Tri-Council. This limits the capacity of CFI staff to engage with their Tri-Council counterparts on a level playing field.

2) What are best practices (internationally/domestically) for supporting big science (including, inter alia, international facilities and international collaboration)?

Building world-class research infrastructure domestically and gaining access to international research opportunities by partnering on major infrastructure projects is critical to Canada's research capacity. Support for big science will become increasingly pivotal as research transcends borders and disciplines in pursuit of solutions to our most pressing challenges. Canada will need to be strategic in evaluating and determining which big science endeavours to partner on and which ones to take the lead in pursuing.

Financial contributions for big science are typically significant, and require a long-term commitment to ensure support over an initiative's entire lifecycle. As such, we must ensure that our investments in big science are targeted to areas of strength or emerging strengths. In order to do this, The U15 recommends:

- Internationally, funding bodies in the **United States**, **Australia** and the **UK** have funded large-scale facilities based on assessments that include initial costs, costs for commissioning, the operating and maintenance costs, a plan for capital upgrades and

decommissioning. It is important to take into account the full cost of participating in big science, both internationally and with Canadian-based big science platforms.
- The establishment of an arms-length expert panel to advise the government on strategic priorities. This panel should include international and domestic experts, and could be included under the Science, Technology and Innovation Council's (STIC) mandate, the Chief Science Officer's mandate, or be convened as a part of a new initiative;
- Proper oversight for funding big science. CFI's Major Science Initiatives (MSI) Fund provides ongoing oversight to fund major national research platforms, demonstrating that funding can be administered and monitored in such a way that is tailored to unique situations facing specific institutions and major projects. Although challenges remain with regard to matching funding for these platforms, particularly in negotiating federal/provincial agreements, establishing recognized world-class research platforms is key to Canada's capacity to engage in big science at the international level; and

3) Many requests for government support for research are not tied to the cycles of the four major research agencies, but they have economic or competitive relevance nationally or regionally, or major non-governmental financial support, or implications for Canada's international standing as an active participant in big science projects or major multi-institutional projects. How can we ensure that the Government has access to the best advice about funding these types of projects in the future?

Our world-class scientists undertake research with significant regional and national implications. They also serve as ambassadors on the world stage as they engage in science diplomacy. Research opportunities are constantly emerging. To ensure that Canada makes the most of these opportunities, an arms-length expert panel must constantly and carefully evaluate our science funding, particularly for big science projects and multi-institute collaborations. This panel should be tasked with advising the government on strategic priorities, including recommended direction with regard to big science, to ensure those priorities align with our national research strengths, based on regular, comprehensive reviews.

Funding of platform technologies

1) What types of criteria and considerations should inform decisions regarding whether the Government should create a separate funding mechanism for emerging platform technologies and research areas of broad strategic interest and societal application? Are there any technologies that would appear to meet such criteria in the immediate term? When there is a rationale for separate funding, how to ensure alignment of funding approaches?

Emerging technologies quickly become foundational to the research enterprise. These technologies become platforms when they cut across an array of disciplines and invest in research. Examples include areas such as:

- Nanotechnology;
- Quantum computing;
- Genomics; and
- Information technology.

In cases where technologies could potentially spin out to dedicated, federally-funded organizations, an arms-length, expert panel should evaluate the platform's capacity to advance broad strategic interest as well as its societal application.

2) Today's emerging platform technology may rapidly become a standard tool used tomorrow by a wide variety of researchers. If such technologies are initially given stand-alone support via a dedicated program or agency, what factors should inform decisions on when it would be appropriate to "mainstream" such funding back into the granting councils?

An arms-length, expert panel must carefully assess any significant changes to the research funding ecosystem. Large-scale and significant changes to the research funding ecosystem, including mainstreaming dedicated agencies back into the granting councils, must be phased in gradually. One possible approach could be to establish platforms within the Tri-Council with an evaluation and sustainability plan to guide discussions regarding timing of funding and mainstreaming. The research community must be confident that these types of changes would not undermine levels of support for ongoing and future research projects. Mainstreaming should only be considered if the granting councils are sufficiently flexible to allow for a seamless transition. Transition plans would entail flexibility with regard to:

- Funding. A flexible fund dedicated to technology would help to gradually introduce changes to the research ecosystem;
- Process. The funding process would need to be phased in gradually to mitigate the impact of changes on ongoing research projects and ensure a smooth transition. This may require bridging funding to ensure continuity of projects; and
- Priorities. A flexible mandate regarding platform funding would allow the granting councils to gradually phase in any changes to the funding process.