CFRS Draft Discussion Paper

Freedom and responsibility in the 21st century: a contemporary perspective on the free and responsible practice of science

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Preface

The International Science Council (ISC) works for the global scientific community: to advance science, to catalyse and share scientific expertise, to provide advice and influence on issues of concern to science and society, and to promote and safeguard free and responsible practice of scientific inquiry. The ISC's commitment to science as a global public good is underpinned by its core Principle of Freedom and Responsibility in Science.

> ***ISC Statute 7:*** *The free and responsible practice of science is fundamental to scientific advancement and human and environmental wellbeing. Such practice, in all its aspects, requires freedom of movement, association, expression and communication for scientists, as well as equitable access to data, information, and other resources for research. It requires responsibility at all levels to carry out and communicate scientific work with integrity, respect, fairness, trustworthiness, and transparency, recognizing its benefits and possible harms.*
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> *In advocating the free and responsible practice of science, the Council promotes equitable opportunities for access to science and its benefits, and opposes discrimination based on such factors as ethnic origin, religion, citizenship, language, political or other opinion, sex, gender identity, sexual orientation, disability, or age.*

The rapidly changing contexts within which scientific research is undertaken and applied have prompted the ISC to re-examine the meaning of scientific freedom and responsibility in the 21st century. This Paper considers new challenges arising from social and technological developments of the last two decades, as well as changes to the ways in which science is used and disseminated. It suggests several key freedoms and responsibilities that must be upheld, to be consistent with the vision of science as a global public good. Finally, the Paper offers guidance to readers in a range of institutional and policy settings on the actions needed to uphold and protect these freedoms and responsibilities

All stakeholders in global science systems are responsible for protecting scientific freedoms, but different stakeholders have different roles to play in this endeavour. Similarly, different stakeholders have different obligations to ensure that the individual and collective responsibilities of scientific researchers are upheld. Building upon the work of others, this Paper describes these roles and obligations for:

- **Researchers** – when conducting research, collaborating and communicating.

- **Research organizations** – when managing and protecting science activities and researchers.
- **The private sector** – when engaging in basic and applied research.
- **Governments** – when developing governance standards and science-policy interfaces.
- **International science organizations** – when fostering scientific collaboration and advocating for the roles of scientists.

The contribution of scientists to human and environmental wellbeing is maximised when they are afforded appropriate freedoms to meet their individual and collective responsibilities. The international scientific community, governments, and the wider public must each develop a clear understanding of, and strategies to achieve, these freedoms and responsibilities. This discussion paper is offered as a contribution to this aim.

This Paper was developed by a Writing Group of scientists appointed by the ISC's Committee for Freedom and Responsibility in Science (CFRS), with oversight from the ISC's Governing Board. The draft Paper will be further developed through consultation with the Council's Members.

1. Introduction

1.1 Freedom and Responsibility in Science

The International Science Council (ISC) works for the global scientific community to advance science, to catalyze and share scientific expertise, to provide advice and influence on issues of concern to science and society, and to promote and safeguard free and responsible practice of scientific inquiry. This activity supports the United Nations Universal Declaration of Human Rights[1*], which includes the right to share in scientific advancement and its benefits, whether as a practicing scientist or a lay citizen. These rights recognize the value of science to human and environmental wellbeing, and the ISC's vision is of science as a global public good[2].

The work of the ISC is underpinned by its core Principle of Freedom and Responsibility in Science[3], which sets out the freedoms that scientists should enjoy, and the responsibilities they carry, as practicing researchers. It is, however, legitimate to ask why scientists need different freedoms from those that are the human right of every individual, and why they have particular responsibilities.

The unique capacity of science to drive intellectual and material change means that it should be enabled to maximize its potential for discovery and for beneficial application. Scientific discovery is favoured by settings where freedom to explore, collaborate and communicate are

[*] For further explanation, please refer to 'Key Terms' (section 9)

upheld and not inhibited by political or religious constraints. Thus, scientists require these professional freedoms in addition to the universal human rights bestowed on all citizens[†].

Scientific discovery is also favoured when researchers maintain the processes that characterize science as a valuable form of knowledge. Scientists therefore have a responsibility to undertake a practice of science that meets globally recognized standards and thereby serves the global public good. In addition, the beneficial application of new scientific knowledge also depends on responsible scientists. New discoveries will be used by societies in accordance with their values and power structures. Thus, scientists have a responsibility to think about the uses to which their work might be put, and to advise the relevant stakeholders of the risks and benefits of these applications.

In emphasizing the interdependency of freedom and responsibility in science, this Paper reflects an important shift in thinking between the 20th and 21st century. In the period after World War II, scientists and policymakers thought of freedom (particularly the freedom of autonomy in setting research agendas) and responsibility (specifically moral responsibility for the social impacts of scientific research) as being in direct conflict[4]. During the early 21st century, this perspective has shifted towards affirming a different understanding – that scientific freedom must come with social responsibility for scientists in all areas of research[5].

1.2 Why this Paper now?

This Paper posits that scientific freedom and responsibility are historically specific concepts. While an understanding of these notions should be informed by the long history of scientific research, today's scientific freedoms and responsibilities are defined by the contemporary context in which scientists work.

In the 21st century, new political tensions as well as ongoing conflicts, discrimination and other kinds of inequalities threaten scientific freedom, both on an individual level and for the wider scientific community. Advances in communications technology, and an increased focus on diversity and inclusion, help to confront such threats, but numerous challenges continue to restrict scientific freedom around the world.

Furthermore, social, and technological developments in recent decades continue to change the way science is practiced around the world. Artificial intelligence, big data, the internet-of-things, and social media all promise benefits to science, but these innovations are accompanied by new responsibilities in the dissemination and use of scientific and technical knowledge. These include individual responsibility and accountability when conducting and communicating research, as well as collective responsibility for research integrity and for maintaining public trust in science. In recent years, this trust has been compromised by

[†] For further explanation, please refer to 'Key Terms' (section 9)

individual cases of scientific misconduct in the form of fraud, plagiarism, fabrication, and falsification, and by lack of reproducibility.

At the collective level, modern science systems also pose threats to freedom and responsibility in science. They include inadequate recognition and reward systems; bureaucratic governance; relations with media; and tensions at the interface between public and private science. However, research is undertaken in a range of settings in contemporary society: universities, government entities at central and local levels, independent research organizations, not-for-profit research organizations, the private sector, and through sole practice and volunteering. Each has its own obligations, revenue sources, operational environment, and contractual and employment arrangements, which affect the freedoms that scientists are afforded, and the responsibilities that scientists need to consider when undertaking their research. Thus, a contemporary understanding of scientific freedom and responsibility requires sensitivity to these modern layers of diversity, taking a broad understanding of science as a collective institution with a range of practices and values.

These trends and challenges have prompted the authors to re-examine the meaning of scientific freedom and responsibility, and the role of bodies such as the ISC in upholding its basic tenets. Global emergencies such as climate change and the COVID-19 pandemic have demonstrated the key role that free and responsible science can play in protecting human and environmental wellbeing, as well as the dangers of failing to uphold these principles. The aim of this Paper is to advance the vision of science as a global public good, by guiding the free and responsible practice of science in the 21^{st} century.

1.3 Process

This Paper was developed by a Writing Group of scientists appointed by the ISC's Committee for Freedom and Responsibility in Science (CFRS), with oversight from the ISC's Governing Board. The text was subjected to three phases of review followed by revision, involving CFRS, select members of the ISC Advisory Committees, and external expert reviewers, before being submitted to the ISC Governing Board for adoption as an ISC Paper.

1.4 Outline

This Paper begins with an overview of historical understandings of freedom and responsibility in scientific research. It then turns to consider new challenges to scientific freedom and responsibility arising from developments of the 21^{st} century. Four principles to underpin contemporary scientific endeavours are introduced, revisiting the work of sociologist Robert K. Merton in the 1940s. Based on these principles, the Paper suggests the key freedoms and responsibilities that should be upheld by scientists in order to advance the ISC's vision of science as a global public good. Finally, the Paper offers guidance to readers on the actions needed to uphold and protect these freedoms and responsibilities.

2. A legacy of scientific freedom and responsibility

People have thought about the questions addressed within this document for much of recorded history. In earlier centuries, a learned priestly class already had to balance intellectual freedoms with specific responsibilities (towards humans as well as Gods), bureaucracies supported and limited the development of new knowledge (e.g., the Chinese scholar-officials or *shih*) and scientific academies could explore any subject on condition of leaving religion or politics aside. But as societies change, so too do perspectives on these issues. Furthermore, scientific freedom and responsibility are upheld by social contracts, and they have been continuously under threat. Freedom and responsibility in science therefore needs to be revisited and reinforced every few decades.

2.1 Institutional and intellectual autonomy

A cornerstone of scientific freedom has been the autonomy of the institution where research is conducted, which includes, most prominently, the university. From their origin in Asia and Northern Africa, universities developed as a legally autonomous corporation of scholars with the right to self-governance, and universities would keep this institutional autonomy when they spread over the world, becoming the dominant institution of higher education and knowledge production.[6]

In the early 19th century, a global reform of universities inspired by the ideas of Wilhelm von Humboldt integrated teaching with research and institutionalized "academic freedom", ensuring the freedom to think, criticize and do research.[7] During most of the 20th century, tenure for university faculty was seen as an important guarantee for academic freedom. While this was stressed e.g., in the context of private universities, where it was feared that private interests would impose certain views on university staff, tenure became a general tool to ward off funder, political and bureaucratic interference[8‡].

Although the Humboldtian ideal continues to shape debates on academic freedom, the university itself has changed radically in the last decades. The massification of education, the expansion of university status to non-research institutions, a new managerial culture, decreasing government funding, the focus on innovation and economically important sectors, demands for impact and accountability, and many more factors, have eroded institutional autonomy of universities since the 1970s and led to a decline in, or abolishment of, tenured positions. In combination with the rise of populism and the related attacks on "intellectuals",

‡ For further explanation, please refer to 'Key Terms' (section 9)

"academics" or the "elite", this decreasing institutional protection poses a serious threat to academic freedom in the 21st century.

2.2 Freedom of thought and expression

Scientific freedom and its relation to ideology and the broader political context became an important topic of global discussion in the interwar years, in the face of totalitarian regimes, and even more so during the Second World War.[9] Some sciences such as biology and ecology had been strongly politicized during Nazi rule.[10] After the War, the most widely discussed case of politicized science was Lysenkoism, a biological theory that dominated the USSR from 1935 to the mid-1960s, leading to the persecution of recalcitrant scientists in the USSR, many Eastern European countries and China.[11] While scientific censorship is seldom so explicit and direct, pressure by political forces, concerns for national security, and other pressures, often lead to self-censorship, implicit alignment and ideological adaptation in the scientific community.

The social sciences and humanities are especially vulnerable to ideological attacks and political pushback as they often study current societal issues and subjects of contemporary debate.[12] In other areas of science, industry interests have influenced scientific results by creating funding biases. The tobacco industry's historical obfuscation of facts about cancer and smoking is now well known, but money has also more subtle distorting effects on medical, pharmaceutical, environmental, and other research.[13]

The discourse of academic freedom is now also turned against the scientific community to defend pseudo-scientific, discredited or fringe theories.[14] In the current climate of a renewed politicization of freedom, it is all the more important to define and defend the principles of scientific freedom and responsibility.

2.3 'Internal' and 'external' responsibilities for science

In 1942, the sociologist Robert K. Merton recognised a pertinent need to defend science from rampant anti-intellectualism, from attacks on the integrity of scientists, and from an assault on the autonomy of science.[15] He argued that a specific "scientific ethos", which results in the generation of reliable knowledge, makes science special and separates it from other spheres of social life. Merton distinguished four key values to guide this ethos: communism (the products of science are shared and belong to the community), universalism (science is impersonal and objective, despite nationalist attempts at the appropriation of science), disinterestedness (results are not influenced by interests external to science), and organized scepticism (the freedom to criticise). From these values emerge a range of actions - or responsibilities - 'internal' to the scientific community, through which scientists could uphold the reliability and credibility of science.

The use of nuclear weapons at the end of the Second World War was a watershed moment for how scientists and the public thought about scientists' 'external' responsibilities to society. Society as a whole became more aware of the destructive or disruptive power of scientific and techno-scientific innovation, ranging from war technologies to pollution and climate change. This has led to continuing debates about the responsibility of scientists for the potential uses of scientific discoveries, unintended negative consequences and societal impact of scientific results.

In the 21st century, it will be important to strengthen the connection between internal responsibilities, external responsibilities, and scientific freedom. While the freedom of science used to refer to "negative freedom" (i.e., freedom from government interference) in the 20th century, it will be important to reframe scientific freedom as "positive freedom" in the 21st century (e.g., freedom to communicate with the public.) Some responsibilities of scientists can only be met if they are afforded appropriate freedoms, but in turn, these freedoms generate other responsibilities. Conditions should be created for a positive and constructive research culture in which scientific freedoms are supported and promoted. Only in such a context can new responsibilities for scientists be seen not as restrictions but as enabling factors. It will then become clear that freedom and responsibility are two sides of the same coin.

2.4 "Free" science versus "planned" science

The Second World War fundamentally challenged scientific freedom in many ways. Nazi Germany not only limited the freedom of scientists by imposing its ideology but also started some of the first government-controlled "big science" projects in biomedical, agricultural and defence research.[16] This started a new debate on freedom in science in terms of free, curiosity driven science versus planned science, which would characterize the two dominant Post-War and Cold War ideologies in science policy.

In 1945, Vannevar Bush, Director of the US Office of Scientific Research and Development, wrote in a report to the President:

> We must remove the rigid controls which we have had to impose [during the war effort], and recover freedom of inquiry and that healthy competitive scientific spirit so necessary for expansion of the frontiers of scientific knowledge. Scientific progress, on a broad front, results from the free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown.[17]

This document provided the blueprint for the US National Science Foundation (NSF), which was founded in 1950 with unprecedented scientific autonomy and freedom of inquiry. It embodied a vision in which scientific freedom was merged with a capitalist ideology of individualism, progress, and competition. Such initiatives were meant to be a counterpoint to the state planning of science, as in the Soviet five-year plans, or the Chinese 12-Year Science Plan.[18]

Despite the rhetoric of freedom in science, based also in political ideology[19] of the time, the prominence of free, curiosity-driven research declined in the second half of the 20th century. This was largely due to the decrease in relative dominance of universities in scientific research, neoliberal reform of universities in many countries, and the push towards project-funded and mission-oriented research. In many places, these changes have decreased the freedom of scientists to choose their topics, the timeline of their research, and how and where they communicate results.

2.5 From freedom of movement to human rights

Various regimes of the 20th century have targeted scientists specifically or as part of a broader group of citizens, from the expulsion of Jewish scientists in Nazi Germany to the persecution of biologists during Lysenkoism. Diplomatic tensions such as the Cold War have hampered the freedom of movement of and collaboration among scientists, and the concern for free circulation and association was at the origin of the International Council for Science's (ICSU) Standing Committee on Free Circulation of Scientists (SCFCS), founded in 1965.[20]

Such concerns highlighted the overlap between scientific freedom and universal human rights, which served to rally the scientific community around wider problems of discrimination, harassment, persecution, and inequality. The interconnected nature of scientific freedom and human rights was subsequently emphasized in a range of treaties, declarations, and legal instruments. For example, UNESCO's 1997 Recommendation concerning the Status of Higher-Education Teaching Personnel considers that "the right to education, teaching and research can only be fully enjoyed in an atmosphere of academic freedom and autonomy for institutions of higher education."

3. The 21st century: new challenges, new opportunities

The 21st century presents new threats and challenges for science, as well as many new opportunities to realize the vision of science as a global public good.

3.1 New media, new scepticism

New media have made science much more accessible to the general public. Access to information has been extended to a much larger share of the population through resources such as Wikipedia, online university lectures, and direct access to scientific publications. However, access to these resources is hampered by poor internet connectivity in many parts of the world. Furthermore, growing tensions between national governments and online platforms risk the accessibility of information in various countries[21].

While those who do have access to online resources experience many benefits, the internet has also facilitated the spread of disinformation, particularly among vulnerable communities. Science has always faced scepticism from some groups in society, but online platforms give this opposition unprecedented visibility. On the other hand, these platforms offer scientists new opportunities to engage directly with public concerns about research, and to combat misinformation with scientific evidence.

For journalism, the rise of social media has dramatically changed the ways in which information is gathered and reported by mainstream media outlets. In some countries, the recent shifts towards digital platforms and 24-hr news cycles have offered scientists new opportunities to reach public audiences as demand for content increased. However, these trends also represent new challenges for science communication, as journalists face increasing time and financial constraints which risk the accuracy, depth, and breadth of science stories[22].

Meanwhile, social media have also altered communication within the scientific community. Scientists too write blogs addressing peer audiences[23], or converse on social networking services[24]. While this can positively impact public opinions about scientists and scientific research, these practices also raise important questions about social responsibility as scholarly debates unfold online. There is a risk that such practices can serve to undermine public trust in journal editorial processes and peer review, giving way to more abrasive forms of scepticism in scientific knowledge.

3.2 Open science

The International Science Council defines open science as[25]:

> Science that is open to scrutiny and challenge, and to the knowledge needs and interests of wider publics. Open science makes the record of science, its evolving stock of knowledge, ideas and possibilities accessible and free to all, irrespective of geography, gender, ethnicity or financial circumstance. It makes the data and evidence of science accessible and re-usable by all, subject to constraints of safety, security and privacy. It is open to engagement with other societal actors in the common pursuit of new knowledge, and to support humanity in achieving sustainable and equitable life on planet Earth.

The essential attributes of open science are: open access to the record of science and to the data of science; access to the digital infrastructures that enable widespread engagement and communication; and open engagement between scientists and other societal actors. This movement introduces new opportunities for advancing science as a global public good through, for example: facilitating interdisciplinary scientific collaboration; enabling public engagement with and understanding of science; increasing the accessibility and utility of scientific evidence and advice in government policymaking processes.

However, this vision of science as an open enterprise is, on both the individual and collective level, dependent upon the full range of scientific freedoms and responsibilities which the ISC seeks to uphold and defend, as outlined in Statute 7. Importantly, the open science movement also introduces new challenges to scientific freedom and responsibility. Freely available research and data create new opportunities for abuse, misinterpretation, and even security risks. While open access publishing has widened access to research results, author-processing charges may raise new hurdles for the Global South, for those in underfunded research fields, or for independent researchers who wish to freely share their knowledge[26]. Digital technologies are central to the evolution of open science, but raise many concerns about privacy and data use, with the need for greater accountability, intelligibility, and accessibility.

3.3 The globalisation of science

The increasingly global nature of scientific enquiry has impacted the entire science system. Rapid changes are occurring in what has been a scientific narrative dominated by male voices, along with Western perspectives on modes of learning, teaching, research, assessment, publication, funding, and governance. This trend has seen the rise of new scientific disciplines as interdisciplinarity has become more important. As the boundaries of countries and languages cease to be a limiting factor to knowledge generation, an increasing recognition of the need for a greater diversity in thought and normative values can be seen with the rise in transdisciplinary approaches, citizen science, and changes to the way the quality and impacts of research are evaluated. Innovative pathways in publishing have emerged, among them a substantial increase in open access journals. More and more countries are investing in and contributing to scientific knowledge, as exemplified by the massive investments in science and technology that have contributed to and accompanied economic growth in India and China.

While the globalisation of science serves to widen the overall knowledge base and creates enormous potential for realisation of science as a global public good, it also creates tensions within the scientific community. New research communities bring their own epistemologies and institutions, their own concerns, and even subtly different appreciations of scientific norms, most conspicuously with respect to individual authorship. Increasingly diverse research communities frequently challenge Western biases and research priorities and raise new questions over shared understanding of quality standards and research ethics.

Asymmetries still exist in the ability of individuals to interact with and access science, creating inequalities in scientific outcomes and an ever more pressing need for responsible research and innovation[27]. Participation by scientists from low-income countries faces the hurdles of limited research funding, inadequate research infrastructures, limited access to library and data resources, or prejudice from global research elites. Within their own countries, newly emerging research communities may struggle with cultural and political tensions that are unfamiliar to scientists from countries with well-established research infrastructures and institutions.

The increased internationalization of science has also introduced new challenges that risk undermining scientific freedoms and the safety of scientists[28]. Scientific exchange and collaboration between researchers in different nations may bump up against political tensions that can serve to curtail the scientific freedoms of exchange and enquiry. Greater openness and transparency, as well as the shift towards online collaboration with the onset of the COVID-19 pandemic, has also meant greater scrutiny and control over scientists' endeavours. For example, growing fears of economic espionage have given rise to research-related policies which may negatively impact the ability of scientists to acquire funding, or to collaborate with peers in certain countries. Meanwhile, governments continue to restrict or frustrate scientists' freedom of movement and association through targeted actions including entry and exit denials, as well as policy-level restrictions frustrating the free flow of ideas across borders[29].

3.4 Managed science: public accountability and output measurement

In the name of public accountability, science has become the object of new managerial regimes that demand demonstrable value for money and other inputs. Research output measures (such as publications, citations, and patents) are intended to achieve fairer allocation of research resources and rewards for excellence. However, these developments have significant implications for the free and responsible practice of science.

Performing to the indicator rather than to the underlying, substantial value of good science may distort research agendas, and skew opportunities between research fields. Scientists may feel obliged or even permitted to redirect research priorities for output purposes, or in the worst case, to take shortcuts in their research to achieve higher output scores. The pressure to justify and bring in sufficient funding can increase the temptation to over-promise the impact of certain research projects, for example extrapolating the results of animal research to human health outcomes.

Expanded output-indicator regimes have resulted in calls for moderation and a return to more qualitative research assessment[30], after a global wave of complaints from researchers across the scientific disciplines.

3.5 Illiberal science policies and the challenge of anti-intellectualism

The institutional conditions to ensure that science is sustained as a collaborative, public enterprise is a fundamental responsibility of public-sector scientific and academic leadership. The policy-for-science relationship between national governments and public-sector science organizations and institutions is a critical one, sensitive to changes in the political arena which can result in science policies that threaten scientific freedoms and undermine scientists' responsibilities. Such a situation presents a significant dilemma for scientific governance.

In the third decade of the 21st century, at a time when scientific research is of critical importance to human and environmental well-being, scientific freedom is under attack in many places. Most notable among these, as noted by the Academic Freedom Index in 2020[31], are increased opportunities for the surveillance of research, teaching, and discourse, increasing pressure for scientific enquiry and teaching to align with political agendas, as well as sanctions, restrictions, online harassment, self-censorship, and isolation[32]. There are growing cases of political interference with academic leadership and with national scientific governance. While these vary across countries, pressures from interest groups and governments can undermine the autonomy of scientific organizations to establish independent leadership and significantly curtail the freedom of scientists to determine rigorous research agendas.

While trust in science remains high among the general population[33], scientists continue to find themselves confronted by critical, distrustful, or sometimes openly hostile popular movements that question their methods, modes of reasoning and even integrity. Some of these movements reject the terms of debate that regulate scholarly argument and challenge the methodologies of scientific practice and communication. In the 21st century, public backlash against scientific research and recommendations have influenced some policymakers to reject responsible, rigorous scientific advice.

3.6 Social engagement and responsible advocacy

National and international efforts to address the challenges facing modern society often require scientists to take up visible, public roles. As spokespersons, panel members, report writers, and advisors, many scientists now operate in closer relation to the rest of society than they have in the past. This mode of operation redefines the societal position and expectations of researchers, including their engagement in responsible advocacy.

Developments in the 21st century have brought scientists increased access to both public audiences and government policymakers, thus increasing their opportunities to advocate for particular issues of concern. Such issues include action on climate change, equitable vaccine distribution, and even scientific freedom itself. Scientists become advocates when they move beyond reporting, clarifying, interpreting, and explaining scientific research to advising and recommending actions to a particular audience[34].

These opportunities raise important questions for the responsible practice of advocacy as a scientist. When communicating scientific research, scientists have a responsibility to provide balanced, understandable information, pointing out possible weaknesses and limitations in the evidence to enable others to make informed decisions. When advocating for a particular outcome, scientists become "partisans" and are no longer neutral conveyors of scientific information. This difference in perspective, as nonpartisan conveyor of information versus partisan advocate, represents a dilemma for the responsible scientist.

3.7 New technological potential

The sciences have contributed enormously to humanity's ability to understand the world, and to change it. New technologies generate unprecedented capabilities that affect human life, including climate engineering, as well as artificial intelligence, big data, robotics, genome editing and predictive medicine.

Much scientific knowledge has dual-use potential, posing risks as well as benefits[35]. These capabilities may offer solutions to the biggest problems of our age, but they also raise concerns over the fair distribution of costs and benefits, the process of decision-making in the deployment of dual-use technologies, the protection of freedom, and potential threats to current and future well-being. Increased capabilities to create and destroy raise difficult questions about scientific responsibility for individual scientists as well as the collective responsibility of science institutions and organizations.

3.8 Science and industry

Basic and applied research have been critical components of industrial development since the late 18th century. During the 20th century, collaboration between scientists working in the private sector, academia, and government increased significantly and by the 1980s, was being deliberately engineered by government ministries overseeing funding for research and innovation.

This development has posed challenges for scientists working in both industry and universities. There are no widely accepted guidelines for how their research relationships should be conducted[36]. There can be significant differences between what scientific freedom, especially the freedom to disseminate the results of research, means in these different contexts.

Private sector funding for research is driven in large measure by company interests, not by an altruistic goal of contributing to knowledge for the wider public good. For scientists based in universities and who are increasingly dependent on funding from industry for their research, this raises potential conflicts between private interests and incentives on the one hand, and public concerns and funding on the other. For example, the publication of research findings in media accessible to the wider public can be significantly delayed, or banned altogether, in the interest of protecting intellectual property resulting from industry funding.

From the late 20th century onwards, there has been a shift in emphasis from investigator-initiated, curiosity-driven, discipline-based research towards mission-led, problem-focused, interdisciplinary projects with specified time horizons for funding. This shift coincides with the growth of co-funding for research by key stakeholders in the private, government and university sectors.

The increasing frequency of public-private scientific partnerships inevitably poses questions about what shared responsibilities and norms of behaviour should be expected of scientists employed in industry or by government agencies, universities, and other non-government organizations. The incentives and codes of practice that generate trust in public science are not necessarily present in other sectors, especially the private sector[37]. However, there are some scientific responsibilities, such as for public safety, that should be fundamental parts of scientific practice irrespective of the context in which science is carried out.

4. Basic principles

As noted in the introduction of this Paper, the sciences have specific freedoms and responsibilities because the cultivation of these freedoms and responsibilities contributes to higher ends. The previous chapters outline how developments in the 21st century pose key challenges to the definition and practice of scientific freedom and responsibility. In the present chapter, four key principles, building upon the framework of Merton's values of the 20th century, are proposed to inform responses to these challenges.

4.1. Science for the common good

The 20th century value of communism posits that the findings of science are common property to the scientific community and that scientific progress relies on open communication and sharing. The ISC is committed to a vision of science as a global public good, applying and extending this value in the 21st century. In practice, the ISC regards and seeks to advance the production of science, its control, acquisition, validation, and use, as a collective social endeavour that is common to all people.

The significant value of science as a common good is recognized by UNESCO as a foundation for the protection of scientific freedom[38]. The 2020 Bonn Declaration[39] asserts that, "freedom of scientific research is a necessary condition for researchers to produce, share and transfer knowledge as a public good for the well-being of society". Private rewards, fame and economic incentives may encourage discovery and innovation, but ultimately it is the common good that is the guiding value of the scientific endeavour.

The sciences contribute to the common good by preserving, transmitting and renewing the knowledge, technologies and skills that help societies to solve problems; increase welfare and wellbeing; reflect on and interpret existential questions; but also to assist with the identification of new problems and threats[40] [41]. Scientific freedom is required precisely to allow science to make these contributions. However, the contributions that scientists and scientific organizations may make to public and private deliberation are restricted by professional standards, determined mainly in expert communities.

It is often legal to perform experiments that are in fact unethical; where there is a question, scientists have a responsibility to look to community and professional standards to help guide them in making their research and experimentation ethical. This creates an insoluble tension, since the freedom to criticise and question professional standards is vital to their renewal and for the prevention of stifling orthodoxies[42]. There are, however, general values that guide all sciences and scholarly debate. Beyond the specific professional standards of a research field, scientists and their institutions are bound by shared values of honesty, fairness, objectivity, reliability, scepticism, accountability, and openness[43].

4.2. Science shared

Ultimately, science belongs to everybody[44]; the scientific knowledge and skills acquired through the ages are the collective heritage of all humanity. An important goal of scientific institutions is not only to discover and interrogate new knowledge, but also to share and explain what is known for the benefit of all.

Research and scholarly enquiry thrive when shared. In articulating the need for organized scepticism within science, Merton emphasised the importance of collective discussion and analysis of scientific research. The principle of sharing science in the 21st century extends beyond addressing other scientists. It also includes the responsibility to engage with different audiences, including policymakers and the wider public[45]. Modern media have dramatically increased the range and diversity of platforms through which scientists can share and debate research findings. Meanwhile, nations around the world have sought to build or bolster their science advisory mechanisms to improve the communication between scientists and policymakers and boost the role of science in government decision-making[46].

The increasing visibility of scientific research in public and political domains means scientists are also called on to defend or debate the management of scientific research. This may involve public justification of how research standards are set and maintained; accounting for and debating research priorities; and explaining ethical and legal restrictions on research[47]. Sharing science in the 21st century is a matter of collective deliberation, listening to stakeholders' concerns, and responsibly representing the scientific community, through transparency, integrity, and clarity.

4.3. Science is universal and diverse

The concept of universalism[48] posits that scientific claims must be held to objective and "preestablished impersonal criteria." Over the past half century, the sciences have come to appreciate that universality does not imply homogeneity or stale uniformity. Science is diverse, with a wide range of methods, concepts, traditions, problems, and fields of application. A range of disciplines, research communities and schools of thought is vital to the pluralism of the sciences. Debate between them offers a rich palette of perspectives and approaches. The ethnic, cultural and gender diversity of research communities is not only a matter of social justice. Scientists with specific backgrounds or experiences may have understanding that is vital to the development of scientific knowledge. Perspectives shaped through gender, race, or culture may enrich insights and inform the consequences and assumptions of research.

The advancement of broad-based, engaged, interdisciplinary and transdisciplinary science is an imperative for understanding and catalysing a scientific response to complex real-world problems. This involves drawing on the wisdom of those formally trained as researchers, as well as those whose knowledge comes from regular work or patient experiences; awareness of particular areas, such as local residents; indigenous epistemologies; and methodical observations by citizen scientists such as committed birders or amateur astronomers.

4.4. The particularity of scientific institutions

The 20th century value of disinterestedness argued that science, as an organized endeavour, should limit the influence of bias as much as possible and should be done for the sake of science, rather than self-interest or power.

The sciences have cultures and institutions that are specific and vital to their operation. Among these are professional organizations such as scientific societies, training programmes, communications channels and reward and certification systems. In such institutions, knowledge is assessed, scholarly debate is nurtured and regulated, and new generations of scientists are trained. The operation and management of such institutions has evolved significantly throughout the history of science, often in the best interest of the scientific community. However, concerns for the impact of bias and conflicts of interest within organized science prevail in the 21st century. This serves both to undermine the notion of scientific responsibility and poses significant threats to scientific freedom. The safeguarding of institutional autonomy, a key value of modern higher education, can mitigate the influence of political agendas and financial interests on scientific research.

In reflecting the diverse nature of modern science, pluralism of organizational forms and research funding streams within organized science is crucial for the flourishing of scientific research. However, such pluralism must not compromise the universal protection of scientific freedoms and responsibilities, but should instead enable the localisation of these global principles.

5. Defining the freedoms and responsibilities of science in the 21st century

This chapter outlines how insights contained in chapters 3 and 4 can inform the practice of science in the modern era. The authors identify key freedoms that scientists should be afforded in order to meet the challenges of the 21st century, as well as the responsibilities of scientists and other stakeholders that arise from these challenges.

5.1 Freedoms and Responsibilities of scientific investigation

5.1.1 Research integrity

The vision of science as a global public good relies on public trust in scientists and the products of scientific research. In order to secure this trust, scientists have a responsibility to behave with integrity. Similarly, scientific institutions and national governments must protect this trust through processes that ensure the responsible conduct of science. Scientific fraud by individuals and systemic failures damage public support for science and thus infringe on the human right to enjoy the benefits of scientific progress.

Among the key responsibilities of scientists is to meet the established standards of their specific discipline in the conduct of scientific research. To advance science as a global public good, scientists must do 'good' science. Acting with research integrity also implies that scientists uphold the basic tenets of a scientific ethic: they should expose their evidence for the truth claims that they make and disseminate their work in the public domain[49]. This responsibility is captured in the 2017 UNESCO Recommendation on Science and Scientific Researchers[50], which states that scientists have a right and responsibility to "pursue, expound and defend the scientific truth as they see it" and to "promote access to research results and engage in the sharing of scientific data between researchers, and to policy-makers, and to the public wherever possible."

The Recommendation outlines several additional responsibilities that scientists must meet in the pursuit of integrity. These include: minimising the impacts on living subjects of research and on the natural environment; managing resources efficiently and sustainably; disclosing conflicts of interest; consulting with communities where the conduct of research may affect community members; and ensuring that knowledge derived from traditional, indigenous, local, and other knowledge sources, is appropriately credited, acknowledged, and compensated, as well as ensuring that the resulting knowledge is transferred back to those sources. Furthermore, the Recommendation argues that scientists have a right to (and therefore must be free to) "express themselves freely and openly on the ethical, human, scientific, social or ecological value of certain projects", and have both the right and responsibility to express concerns where research projects undermine human welfare, dignity and human rights, or is "dual use".

The maintenance of research integrity is a responsibility for research organizations as well as for individual scientists. Such organizations should encourage a culture of research integrity through information, dialogue and transparency, incentive management, and procedures to deal with misconduct. This responsibility for supporting a culture of research integrity also extends to professional associations, the publishing sector[51], and funders and governments, as well as civil society and journalists[52]. Institutional measures should respect scientific freedom and diversity, facilitating responsible behaviour rather than stifling vibrant scientific culture. While scientists can be expected to behave with integrity, and be held accountable when they do not, research integrity requires respect for their freedom as well as for their diverse perspectives.

5.1.2 Scientific ethics

Science is a never-ending quest for knowledge, but scientists must reflect on the impact of their activities. According to François Rabelais[53], a physician of the early 16th century, "Science without conscience is but the ruin of the soul."

Science ethics is the reflection on this conscience, and in this context three levels can be distinguished. These levels relate to direct consequences of scientific activity, possible damage caused by applications of science, and warnings about possible hazards.

The first level concerns the ethics of scientific experiments and gathering data, such as for clinical trials in medicine. These must respect human values, rules for animal experimentation, and concern for the environment.

At the second level, studies of innovation show how difficult it is to anticipate the dangers of applying scientific knowledge. Nevertheless, scientists must reflect on possible harm or misuse, and warn the public about uncertainties and potential harm. Examples include genetic manipulation using CRISPR-Cas9 techniques, Artificial Intelligence, High Energy Physics, machine learning, and Big Data technologies. Big Data brings new challenges to privacy, which must be communicated clearly. It can be difficult to explain the advantages of innovation based on sound scientific knowledge even to other scientists, for example to issues raised by the implementation of experimental fracking sites.

To fulfil their responsibilities at the third level, scientists must communicate the uncertainties and long-term effects of technology for the planet, especially climate change. They must signal the risks, explain them, and propose solutions, thereby helping society to sift through the available information and make scientifically informed decisions.

5.1.3 New technologies

Emerging technologies often involve the complex interaction of several disciplines, such as engineering and mathematics with biology, or robotics and artificial intelligence with life sciences. Hans Lenk has said[54], "As technology gets more complex, the problem of responsibility gets more complicated." New technologies raise a number of questions for scientific freedom and responsibility, including the ethical use of gene technology, and the security of open access data. The aim should be to avoid Collingridge's Dilemma55, whereby new hazards arising from technology cannot be predicted, and older ones cannot be removed. The case study below explores these issues with the example of CRISPR technology.

Case Study A: Heritable Human Genome Editing

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeat) is a technique which allows genomes to be edited more simply, more cheaply and more accurately than before[56]. It can be used on somatic cells to yield changes that are not inherited by offspring, as well as on the genome to generate changes which may be passed onto future generations.

An example of CRISPR's use on somatic material occurred in May 2020, when it was used in an attempt to restore some vision to volunteer patients. This type of use is more widely accepted than genomic applications, which modify early embryos, eggs, sperm, or precursor cells that can be used to establish a pregnancy. Heritable Human Genome Editing (HHGE) is particularly controversial because human reproduction touches on societal and personal values.

The first question that arises about HHGE is whether it is safe. Most inherited traits are polygenetic, the result of hundreds of genes acting in concert, together with many environmental factors. Altering genes is risky and uncertain, so attention has focused on so-called "single-gene" diseases such as cystic fibrosis and sickle cell anaemia, those caused by a relatively small number of genes. However, even the genetic interactions underlying these conditions are not fully understood.

The first human beings known to have been genetically edited are Lulu and Nana, twin girls edited in a lab run by He Jiankui and born in China in 2018. There is now consensus that this experiment should not have been performed. The trait which it was designed to add, HIV resistance, is polygenic, the gene which was altered, CCR5, is not well-understood, and there are established alternatives such as sperm-washing.

Yet developing this much consensus has been hard work. A series of commissions and reports now offer a pathway to tackle the complexities of HHGE governance. The most influential are the 2017 Human Genome Editing consensus report by the US National Academies of Science and Medicine[57], the 2020 International Commission on the Clinical Use of Human Germline Genome Editing[58], and the 2020 World Health Organization (WHO) Draft Framework for Governance on Human Genome Editing[59]. As the WHO Draft Framework points out, the ethical and societal questions raised make governance challenging, as different societies will have differetnt answers to some of these questions.

These reports recommend that even when it is deemed "safe, HHGE should be used primarily to prevent "serious disease" when no "reasonable alternative" exists. But even this formula is controversial. The severity of a disease is often contested, and the definition of "reasonable alternatives" may depend on the parents' desire for genetically-related offspring. Like any technology, CRISPR also raises questions about societal impacts and justice. Who will have access to this technology? Large resources currently flow to genetic engineering companies. Will HHGE exacerbate existing inequities in healthcare?

All these questions are exacerbated when one considers modifications intended for human enhancement as opposed to remedies for disease. This complex subject stresses the need for responsible action by scientists and scientific organizations, and the effective engagement of both policymakers and civil society.

5.1.4 Responsible research management

Research management involves private and public funders, universities, research institutions, the private sector, scientific societies, academies, journals, and publishers. Though each group has its role, all of them have common responsibilities which call for clear, well-crafted rules that protect scientific freedoms and promote responsible conduct.

In the early 21st century, modes of managing and evaluating research through output indicators and even financial rewards have spread internationally. In their most extreme form, the inappropriate use of quantitative research performance metrics contributes to academic labour insecurity and disturbs scientific quality assurance and disinterested assessment. At their worst they can encourage fraud, from citation rings to data fabrication. Those in management positions within global science systems must attend to calls to re-evaluate these systems and to mitigate against their risk to the free and responsible conduct of science.

The growing interdisciplinary and globalised nature of scientific research also call for those involved in research management to consider new management systems which harness the benefits of these trends while combatting the challenges they pose to scientific freedom and responsibility. Crucially, the freedom of scientists to comment on the institution in which they conduct their research must be protected by all management systems, in accordance with globalised-recognised definitions of academic freedom[60].

5.1.5 Science in the private sector

The private sector forms a large part of the research ecosystem and makes the biggest contribution to most national research budgets. Moreover, the share of the private sector in research expenditure is tending to increase, including for basic research. Even in frontier fields, it appears as if most research is now being conducted by the private sector.

There are at least two contexts within which science is conducted in the private sector. The most significant is the research undertaken by scientists employed by firms as part of their regular business operations. The freedoms and responsibilities of scientists working in such firms are heavily influenced by their employment contracts and by any guidelines relating to professional standards and ethics that apply within the firm. It is unlikely that many scientists working in private sector firms are connected to institutions or organizations that have direct links with the ISC.

But there are two contexts linked to the ISC in which scientists working in the tertiary sector, the private sector and the public sector interact and may be required to abide by common codes of professional standards and ethics. These are the international scientific unions and national academies that are member bodies of the ISC. Some of these unions and academies have programs recognizing research excellence in basic as well as applied science. Agreement to abide by certain codes of conduct can be a condition of membership of these unions and academies. But these institutions are heavily dominated by scientists based in tertiary institutions; representation of scientists employed in the private sector and in government agencies tends to be low.

A second and increasingly important context for research funded by the private sector is collaboration with scientists in universities. In many countries, universities and university-based researchers are growing ever more dependent on private funding[61]. Thus, for some scientists based in universities, private concerns and incentives outstrip public funding. A number of critical questions arise from the private sector's engagement with scientists in universities. How is the relationship between private funding and otherwise publicly funded universities and scientists currently regulated? What are the rules of engagement? What are the ethics that underpin these rules of engagement? What are the freedoms and responsibilities that attach to these arrangements? Are there some aspects of scientific good practice (as suggested above in section 3.8) that apply in all types of scientific organization? The answer appears to be that currently there are no widely accepted rules governing this engagement.

Achieving consensus over a set of national standards relating to sound research practice, including freedoms and responsibilities of scientists engaged in research, is not straightforward, as New Zealand's national academy, the Royal Society Te Apārangi, found in 2018 when it led an initiative to establish a Research Charter for Aotearoa New Zealand[62]. The consultations involved universities, Crown research organizations, independent research entities, the government ministry responsible for allocating public funding approved for research, and the government's chief science adviser forum. Conspicuous by its absence from the consultations was research funded by industry, except that share contracted out to universities and other research organizations. There is no umbrella organization that represents private sector research. This makes it difficult to consult over agreed national standards relating to research, including the freedoms and responsibilities of scientists engaged in research.

5.2 Freedoms and Responsibilities in scientific collaboration

5.2.1 Globalisation of science

Science is increasingly characterized by interdisciplinary and international synergies[63]. Such international scientific collaboration can result in unprecedented innovation in the pursuit of mutual benefits as exemplified by scientific collaboration to develop vaccines for COVID-19.

As communication channels have opened and diversified with digital technologies and the massive, pandemic-driven movement to online teaching and research collaboration, so has the onus fallen on academic institutions, governments and research commissioning parties to create the necessary conditions to enable free and responsible scientific exchange, teaching and collaboration in which there is room for the respectful expression and exploration of diversity of approaches, and to protect their scientists from coercion and pressure from the government, commissioning parties, funding bodies and colleagues.

The increased involvement of citizens, the private sectors and civil society (including internationally) in scientific research, and the trend for co-financed and contract-funded, mission-oriented research, requires balancing scientific freedom and independence with social responsibility. Scientists in their role as researchers should take reasonable account of the interests of those involved in their research and those of their environment. Commissioning parties have a responsibility to respect scientific freedom, institutional autonomy, the health and safety of scientists and related local and global responsibilities to society[64]. National governments have an additional responsibility to maintain unfettered research and education to a sufficient degree. In the absence of a supportive environment, academic institutions and other research-producing entities will be unable to impart the major competitive advantage and global recognition sought from them[65].

The intended primary outcome for international scientific collaboration is to avoid or minimise harm to, and uphold the fundamental rights of, those involved and/or impacted by specific transnational collaborations, and internationalisation more generally, thereby strengthening the protection of scientific freedom and the scientific community[66].

5.2.2 Open science: sharing with care

Sharing scientific knowledge openly is a principle that should guide the scientific publication system, access to scientific data, and public engagement in science[67]. But it is important to design these systems whereby the reliability and validation of data and scientific results are ensured. Researchers in low-income countries or ill-financed research fields should not be disadvantaged due to publication charges or payment for data access. Governments and research organizations need to take action if open access is abused, such as in predatory publishing[68] or in the uncredited appropriation of research.

Sharing science openly involves consideration for the different values of different scientific disciplines, as well as the values of different audiences. Scientists should assist meaningful access to their research with adequate documentation that supports correct interpretation, verification, and reuse. This includes the clarification of uncertainty. Shared knowledge should explain which quality assurance procedures it has passed by documenting peer review and applied research standards. Scientists should explain the limitations of findings that are shared quickly but without verification, such as pre-prints or early releases to the press or social media.

5.3 Freedoms and Responsibilities for scientific critique

There are times when scientists must challenge one another to uphold their individual and collective responsibilities. This includes the organized process of peer review, whereby select individuals are given the responsibility to carefully assess the methodology, data, and truth claims presented in a scientific publication. A key tenet of this process is that both the authors and the reviewers of publications should be protected from undue influences on their independent judgement, and all scientists have a responsibility to disclose both perceived and actual conflicts of interest.

Where there is evidence of professional misconduct, the wider scientific community has a collective responsibility to protect public trust in research by supporting responsibly critical scientists. In order to meet this responsibility, individual scientists must have the necessary scientific freedoms. This includes access to data, and freedom to speak out in their areas of expertise without fear of repercussions.

5.4 Freedoms and Responsibilities for science communication

As discussed in sections 3.2 and 4.2, science communication takes various forms with various audiences: communication within the scientific community, both formally and informally; communication between scientists and policymakers through scientific advisory mechanisms; and communication between scientists and the public, as individuals or en masse.

In accordance with UN Declaration of Human Rights and the International Covenant on Economic, Social and Cultural Rights, researchers are duty-bound to make scientific knowledge accessible to public audiences with differing levels of science literacy[69]. Developments in the 21st century raise new personal and collective responsibilities for scientists when engaging in science communication through the media. These include, *inter alia*, consideration for the needs of diverse audiences; awareness of misinformation, disinformation, and conspiracy theories relating to science issues; appreciation of the pressures facing modern media outlets; and acknowledgement of the impact of personal social media use on public perceptions of scientists. In all forms of science communication, scientists are personally responsible for communicating scientific work with integrity, respect, fairness, trustworthiness, and transparency, recognizing its benefits and possible harms[70].

In order to meet these responsibilities, scientists must be afforded specific freedoms. While all people are entitled to the human right of freedom of expression, scientists should also enjoy the right to protection for academic expression when sharing knowledge within their scientific expertise outside the lab or classroom (so-called extramural expression[71]). According to UN recommendations, and in line with a contemporary view of higher education[72], the sharing of scientific expertise through mainstream or social media should be understood as an exercise of academic freedom. When scientists engage in expression outside of their academic topic – that is, not only outside the substantive area but also methodologically – they retain the right to freedom of expression guaranteed by human rights law, even if that engagement is not considered a part of their academic freedom.

Crucially, scientists should not be punished by their institutions, governments, or private actors for exercising their rights to academic freedom or to freedom of expression when participating in science communication activities[73].

Case Study B: Scientific freedom and responsibility in times of emergency

Scientists have a range of vital roles to play during emergencies, for which they require scientific freedoms. These roles include conducting primary research, peer reviewing new findings, establishing scientific consensus, and communicating evidence to key stakeholders. Each of these roles carry their own responsibilities, which must be navigated carefully in the context of considerable pressure[74].

When undertaking research, scientists must take an ethical and socially responsible approach that is respectful of the affected communities[75]. When assessing the research of others, scientists are responsible for identifying signs of malpractice, as well as errors made in haste[76]. Knowledge emerges rapidly in the context of emergencies, and it is critically important that scientists convey uncertainties in ways that will be understandable to the public and to policymakers in order to protect societal trust in science and promote effective decision-making[77]. In all these roles, scientists must be responsible advocates for the scientific process, supporting the use of the best available evidence and ensuring balanced communication with society.

The COVID-19 pandemic illustrates what can be effective, and what can go wrong, when scientists respond to a global crisis. The sharing of data and knowledge across research teams, institutions and countries has been laudable, as have the number of research groups that have quickly pivoted their attention to the virus. Beyond their primary research, experts have engaged in clear, consistent, and creative modes of communication which have served to boost public trust in scientific research and to promote adherence to public health guidelines[78].

However, there has been an unprecedented dissemination of non-peer reviewed and retracted publications, underscoring the need for better curation of the literature[79]. Those who have tried to call out shortcomings in emerging research have been subjected to harassment and intimidation from their peers[80]. In some countries, scientific debate has clouded decision-making by key policymakers, while in others, governments have denied researchers their scientific freedoms[81] and have failed to utilise scientific evidence in their pandemic response[82].

Emergencies, such as the ongoing pandemic, pose unique and wide-reaching challenges to the free and responsible practice of science. These include time pressures, funding shortages, infrastructure barriers, public confusion, and political hostility. At the same time, it is clear that the principles of freedom and responsibility are key to an effective use of science in combatting emergencies. Scientists must be protected and supported with the necessary freedoms to pursue effective research and communication, while also being held to accountable for the responsibilities they hold in these endeavours.

6. Conclusion

This Discussion Paper concludes on an optimistic note. Science is a unique human activity that, over time, has given us deep knowledge of ourselves and our place in the universe. Broadly defined, the sciences, including technology, the social sciences and humanities, have played vital roles in the human story in the 21st century. Researchers are key members of contemporary society. Their contribution to human wellbeing and to planetary health is maximized when they are allowed appropriate freedoms to meet their individual and collective responsibilities. The international scientific community, governments, the public, and private research institutions should each have a clear sense of their freedoms and responsibilities, and a clear strategy to achieve the free and responsible practice of scientific research

7. Recommendations

ISC is committed to a vision of science as a global public good. This is a vision with profound implications for the ways in which science is conducted, how it is used, and the roles it plays in society. The authors hope that this Discussion Paper will help different stakeholders in the global science community to appreciate the need for free and responsible science, and to pioneer new ways to promote this endeavour at a vital point in human history. To that end, the following recommendations summarize the key messages of this Paper for these stakeholders and highlight tools to protect and uphold scientific freedom and responsibility in the 21st century.

7.1 Researchers

Scientists require both individual and collective freedoms in order to pursue high value research. At the same time, each researcher carries a number of individual and collective responsibilities, which vary according to their scientific discipline and professional role.

In response to the challenges and opportunities posed by the 21st Century, the ISC seeks to uphold four fundamental freedoms for scientific researchers:

- Freedom of movement;
- Freedom of association;
- Freedom of expression and communication, and
- Freedom of access to data and information.

These are grounded in internationally recognized human rights statements, treaties, and instruments, including the United Nations Universal Declaration of Human Rights[83], the International Covenant on Civil and Political Rights[84], the International Covenant on Economic, Social and Cultural Rights[85], and the UNESCO Recommendation on Science and Scientific Researchers[86]. These instruments serve as valuable tools with which researchers should defend their scientific freedoms.

While scientific freedoms should be enjoyed consistently throughout a scientific career, the responsibilities of researchers evolve with time and experience. Broadly, this Paper makes the following high-level recommendations for responsible research in the 21st century:

When conducting research, scientists must:

1. Act with integrity;
2. Meet the international standards of ethical practice within their discipline, and;
3. Consider the unintended consequences, including the dual-use potential of their findings.

When collaborating in research, scientists must:

1. Uphold the rights, and consider the interests, of all those involved in collaborative research;
2. Assist access to research, and;
3. Respect and embrace diversity in the scientific community.

When communicating research, scientists must:

1. Consider the needs of diverse audiences;
2. Explain uncertainties in scientific evidence and signal risks of emerging technologies, and;
3. Challenge misinformation.

7.2 Research organizations

Institutions which fund and/or perform scientific research face a range of pressures in the 21st Century, including financial constraints, the complexities of transnational collaboration, political interference, and in some instances the impact of armed conflict and acute or ongoing humanitarian disasters. This Paper proposes two main opportunities through which research organizations can promote the free and responsible practice of science in the face of these challenges.

In managing science, research organizations must:

1. Uphold rigorous standards of research integrity;
2. Deal with scientific misconduct fairly and consistently;
3. Adopt appropriate performance evaluations for research and researchers, and;
4. Encourage and facilitate the communication of scientific evidence to societal stakeholders, including the public and policymakers.

Research organizations, in protecting researchers, must:

1. Protect and promote scientific freedoms and the responsible practice of science through legislation and culture;
2. Implement support and guidance for the professional development of researchers;
3. Defend institutional autonomy from external influence, and;
4. Protect staff from coercion and pressures, including from political, religious and commercial vested interests.

The 2020 Magna Charta Universitatum[87] offers a valuable tool for universities and contains principles of academic freedom and institutional autonomy as a guideline for good governance. Similarly, the UNESCO Recommendation on Science and Scientific Researchers[88] provides a comprehensive list of rights and responsibilities of research institutions.

7.3 Private sector

As discussed in Section 5.1.5, increasing private investment in scientific research offers new opportunities to researchers around the world. However, a major challenge when conducting research within the private sector, or with private funding, is the lack of national governance, and of internationally agreed standards, in this domain.

A key recommendation emerging from this Paper is the development of frameworks and infrastructures through which such governance and standards can be secured, with an emphasis on protecting scientific freedoms while upholding responsibilities at all levels.

7.4 Governments

National governments can pose a significant threat to scientific freedom and responsibility. In addition to an existing range of declarations, instruments and treaties which list the responsibilities of governments in safeguarding science and scientific researchers, this Paper proposes that national governments must:

1. Adopt and enforce standards for ethical practice in scientific research;
2. Adopt legal frameworks which respect scientific freedoms and the autonomy of research institutes;
3. Encourage science communication and public engagement with scientific research;
4. Ensure scientific freedoms while protecting national security;
5. Nurture diversity in science through agenda-setting and funding strategies;
6. Foster effective science-policy interfaces to utilise and safeguard scientific advice, and;
7. Monitor and report on the state of science and scientific researchers, according to international standards.

7.5 International science organizations

Science organizations that span national and regional borders have a unique role to play in promoting science as a global public good. This Paper highlights the various responsibilities of such organizations in addressing the challenges of the 21st century, and in capitalizing on the opportunities this period brings. Four key recommendations emerge from these responsibilities:

1. To foster international scientific collaboration, including advocating for sufficient funding and appropriate tools for transnational collaborate across borders in diverse cultural, scientific, and legal environments;
2. To promote diversity in the global science community;
3. To protect the principle and practice of open science, and
4. To advocate for the role of scientists in national and international policymaking.

8. Key Terms

<u>Science</u>

The ISC has a broad understanding of the sciences, in all their diversity, covering science as a collective institution with a broad range of practices and values, but also scientists as a community.

> "The word science is used to refer to the systematic organization of knowledge that can be rationally explained and reliably applied. It is inclusive of the natural (including physical, mathematical and life) science and social (including behavioural and economic) science domains, which represent the ISC's primary focus, as well as the humanities, medical, health, computer and engineering sciences (ISC, 2018)". [from: https://council.science/high-level-strategy/]

The term 'scientists' includes persons who are professionally engaged in and responsible for research and development. It is inclusive of social scientists, although some may not identify with the term, preferring 'researchers' or 'scholars'.

<u>Human Rights</u>

The term "human rights" refers to a set of legal claims to protection and benefits that are anchored in internationally recognized human rights statements, treaties and instruments. These include the United Nations Universal Declaration of Human Rights (1948) and two subsequent treaties, the International Covenant on Civil and Political Rights (1966) and the International Covenant on Economic, Social and Cultural Rights (1966). This understanding of "human rights" includes legal obligations on States and their agents to respect human rights, to promote human rights, and to protect people in their territories against human rights violations.

According to Article 27 of the Universal Declaration of Human Rights:

> Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits.

This is further ratified in Article 15 of the International Covenant on Economic, Social and Cultural Rights, whereby State Parties must protect the right to:

(a) Take part in cultural life;

(b) Enjoy the benefits of scientific progress and its applications; and

(c) Benefit from the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author.

The universal right to access and share scientific information is included under Article 19 of the International Covenant on Civil and Political Rights, which states that:

Everyone shall have the right to freedom of expression; this right shall include freedom to seek, receive and impart information and ideas of all kinds.

Scientific Freedom

The notion of scientific freedom is referred to explicitly in the 1966 International Covenant on Economic, Social and Cultural Rights. According to Article 15 (3) of this Covenant, States must undertake to respect the "freedom indispensable for scientific research".

The General Comment on Article 15, published by the UNESCO Committee for Economic, Social and Culture Rights in 2020, elaborates on this freedom, in accordance with the 2017 UNESCO Recommendation on Science and Scientific Researchers. According to these documents, scientific freedom includes, at a minimum:

- the freedom of researchers to pursue, expound and defend the scientific truth as they see it, with protection from undue influence on their independent judgment;
- the possibility for researchers to set up autonomous research institutions and to define the aims and objectives of the research and the methods to be adopted;
- the freedom of researchers to freely and openly question the ethical value of certain projects and the right to withdraw from those projects if their conscience so dictates;
- the freedom of researchers to cooperate with other researchers, both nationally and internationally; and
- the sharing of scientific data and analysis with policymakers, and with the public wherever possible.

The 2017 Recommendation also calls for the freedom of movement for researchers, and places on Member States the responsibility to ensure that all scientists enjoy equal access to science and scientific freedoms without discrimination of any kind.

These rights and responsibilities underlie the ISC's Principle of Freedom and Responsibility in Science.

Academic Freedom

The 1997 UNESCO Recommendation concerning the status of higher education teaching personnel defines academic freedom as:

> "The right, without prescription by prescribed doctrine, to freedom of teaching and discussions, freedom in carrying out research, and disseminating and publishing the results thereof, freedom to express freely their opinion of the institution in which they work, freedom from institutional censorship, and freedom to participate in professional or representative academic bodies."

This was the first major attempt at defining and consolidating academic freedom principles at the international level. It is rooted in international law, including the Universal Declaration of Human Rights, the International Covenant on Economic, Social and Cultural Rights, and the International Covenant on Civil and Political Rights. Unlike scientific freedom, academic freedom is not explicitly referred to in these instruments, but much of its meaning is covered by protections relating to freedom of opinion and the right to education. Academic freedom can be considered as a special, 'enhanced' form of freedom of science, applicable to scientists in higher education institutions only.

Institutional Autonomy

Institutional autonomy is a key component of academic freedom. Academic institutions should have the freedom to manage their core activities of research and teaching without fear of political or religious interference. According to the 1997 UNESCO Recommendation, Member States and higher education institutions should ensure a "proper balance between the level of autonomy enjoyed by higher education institutions and their systems of accountability."

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10. Appendix: Paper production and review

This Discussion Paper drew from a framing document drafted by Daya Reddy, ISC President 2019-2021 and CFRS Chair. The Framing Document responded to deliberations within the ISC and CFRS on the need for a re-examination of the meaning of scientific freedom and responsibility in the 21st century.

10.1 Writing Group members

The Paper was developed by an Expert Writing Group of scientists appointed by CFRS, with oversight from the ISC's Governing Board. The text is being subjected to four phases of review followed by revision, involving CFRS, select members of the ISC Advisory Committees, a global consultation with ISC Members, and a review by external expert reviewers. The final version of the Paper will be submitted to the ISC Governing Board for adoption as an ISC Paper.

The Expert Writing Group group members are:

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10.3 Reviewers

Members of the ISC's Committee for Freedom and Responsibility in Science and members of the Governing Board of the International Science Council.

External Reviewers:

The Paper will be sent to independent experts for review.