Scientific Relations Between Academia and Industry: Building on a New Era of Interactions for the Benefit of Society

Report from an International Workshop on Academia-Industry Relations Sigtuna, Sweden, 22-25 November 2011

Organised by the Committee on Freedom and Responsibility in the conduct of Science (CFRS) of the International Council for Science (ICSU) in partnership with The Royal Swedish Academy of Sciences and The Royal Swedish Academy of Engineering Sciences

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About this report

Carol Corillon and Peter Mahaffy wrote this report in their capacities as members of the Committee on Freedom and Responsibility in the conduct of Science (CFRS), which is a policy committee of the International Council for Science (ICSU) that was one of the organisers of the meeting.

To facilitate the free and open exchange of ideas, the meeting organisers assured participants that comments made over the course of the four-day workshop would not be attributed to individuals in subsequent reporting. While not attempting to be a consensus document, the report presents some of the issues on which a general agreement emerged at the Sigtuna workshop. A draft version was circulated among all workshop participants and all CFRS members for comment. The final report is posted under CFRS in the publications area of the ICSU website.[1] By highlighting the challenges that lie ahead, CFRS hopes to stimulate further dialogue that will help develop and strengthen industry-academia relations that, in turn, will benefit society.

[1] http://www.icsu.org/publications/@@category_search?path=/icsu/publications&Subject:list=General%20publications

Introduction

The emerging era of science-based collaborations between academia and industry offers advantages to both entities and a means by which academic institutions and industry can address global challenges to their mutual benefit and the well-being of society. When academia-industry partnerships work well, they can facilitate research discoveries reaching the people who need them and serving the purposes for which they are required, at affordable prices. Additionally, the combined credibility and influence of academia and industry can achieve beneficial results for society more readily than when the sectors work in isolation. Governments and international organisations can encourage, embrace, and actively facilitate such partnerships. But how? Why are there not more partnerships? What are the advantages and hindrances? What, specifically, can governments and international scientific organisations, such as the International Council for Science (ICSU), do to help promote best practices in such cooperation?

Clearly, partnerships need careful design, implementation, and monitoring to meet local, regional, and global needs, and to ensure that science benefits society. In considering new ways in which academia and industry might work together, overarching questions also are raised. Can increased collaboration between academia and industry drive alternative business models for cases where existing market-based practices have failed to realise a role for science in addressing grand challenges of the 21st century, particularly those affecting the least developed countries of the world? In addition, if academia and industry expand collaboration, can they, together, contribute to the creation of coherent long-term strategies and economic structures for a more sustainable world? Could such partnerships have the critical mass and credibility to speak out against the self-interested approach that is often prevalent today, in a world desperate to emerge from recession?

The requirements necessary to establish strong and mutually rewarding partnerships, the hurdles that must be overcome, and the added benefits to society that could emerge, formed the basis for discussions at a November 2011 workshop in Sweden, where 54 international participants considered aspects of scientific freedom and responsibility arising from historical and emerging models for industry-academia relations. As described in this report, the discussions led to yet more questions, some new insights, and the articulation of the beginnings of a vision for a way forward that includes an on-going role for the International Council for Science and its members.

Emerging from the workshop are suggestions for necessary characteristics of productive academia-industry scientific relations that are consistent with the balance between freedom and responsibility in the conduct of science that is the remit of the ICSU Committee on Freedom and Responsibility in the conduct of Science. These characteristics include the need to:

- Overcome approaches based almost exclusively on self-interest without consideration of the benefits to society;
- Promote relationships that encompass research and innovation, as well as education and service to society;
- Begin relationships with legal agreements that include equitable intellectual property and commercial rights;
- Understand that academia's primary function is education, learning, research, and knowledge generation, while that of business is to produce products and services for societal needs with an economic return, but also understand that the two primary functions are not mutually exclusive or incompatible;
- Maintain openness, transparency and flexibility;
- Establish respect for each other's work environments, ethical standards, values, goals, and objectives;
- Encourage all parties to recognise and strengthen the role of academia as a trusted actor with a long term vision of service to all of society;
- Learn to communicate clearly and in the other sector's language to help establish long-term partnerships;
- Build trust and good working relationships;
- Encourage inter-cultural understanding to better facilitate cross-pollination;

- Use free and open sourcing of data and information as the customary basis for collaboration;
- Understand that patenting can be desirable and beneficial and that both publication and patenting promote openness, but on different terms and conditions;
- Facilitate the ability of students and academics to gain experience in business settings and of industrial professionals to work in academic settings;
- Use those who have worked in both industry and academia as go-betweens, facilitators or liaison officers;
- Help the academic sector in developing countries build capacity through scientific research, the establishment of intellectual property policies and industrial collaborations;
- Use the tools of science and technology, along with others, to minimise and mitigate environmental impact;
- Encourage governments to design and implement economic incentives and to take other steps that will promote best practices in academic/industry partnerships;
- Nurture new business and partnership models to fully exploit new knowledge and technologies for benefit of society;
- Promote an active dialogue between academia, industry, and the public sector;
- Identify what international science and other organisations can do to assist and promote such cooperation.

Global contexts and grand challenges necessitate a new era of science partnerships

The meeting place for the international workshop was close to where an academic – Professor Svante Arrhenius –, presented a remarkable paper to The Royal Swedish Academy of Science on 15 December 1895, entitled "On the influence of carbonic acid in the air on the temperature of the ground."[2] The conclusions of his basic research caused considerable scientific controversy, and it took a great deal of time for the scientific community, and even longer for society, to realise its importance. While other aspects of the work of Arrhenius targeted commercial applications, this paper exemplifies 'blue sky' academic research. It was a contribution to fundamental science carried out to increase understanding of whether the 'greenhouse effect' could explain the temperature variations between glacial and interglacial periods. Eventually it played a crucial role in the development of our 21st century understanding of the mechanisms for regulation of our planet's energy balance and temperature.

While the geographical setting for the workshop was very close to where Arrhenius delivered his academic paper, the world has changed profoundly in the intervening 116 years.

Innovation by both academia and industry has substantially contributed to enhancing the quality of life, but primarily in the developed countries. As one participant pointed out, it is not only research and technology that is needed for innovation to flourish, what is also needed is "a creative culture, the acceptance of failure and a specific inspiring environment." The suggestion was to create "interdisciplinary teams with members of deliberately different cultures, experiences and education (...) to generate new ideas and solutions not yet known." Since the time of Arrhenius, both academia and industry have developed a remarkable capacity to use the tools of science and technology to address societal challenges. Ten years after the US$ 3 billion effort by about 3,000 people in six countries led to the publication of the draft human genome sequence, workshop participants heard of the almost routine sequencing of individual human genomes, bringing closer possibilities such as addressing disease through personalised medicine. These profound accomplishments would not have been possible without openly available data for both academia and industry to use in a pre-competitive manner. Speakers reminded the workshop participants of biomedical innovations that have contributed to substantial increases in lifespan, including the artificial heart, revolutionary pharmaceutical products, and diagnostic equipment such as X-rays and MRI instruments.

[2] S. Arrhenius, 1896. "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground," *Philosophical Magazine*, 41, 237-276. Extract from a paper presented to the Royal Swedish Academy of Sciences, 11th December 1895.

Interactions between academia and the private sector (industry, business, and finance) have also led to revolutionary innovations in areas such as energy production and use, personal transportation and information technology. In addition, since the time of Arrhenius, globalisation has transformed almost every aspect of our world, including access to knowledge and the nature of education, research, and commerce.

Along with these successes, participants discussed vexing 21st century global challenges, such as the results of collaborative work led by academic researchers at the Stockholm Resilience Centre, to define and begin to quantify nine planetary boundaries that constitute the "planetary playing field" for humanity. If humanity is to avoid major human-induced environmental change on a global scale, it must not transgress these boundaries. Yet, analysis shows that we have already exceeded three of the nine boundaries – describing climate change, rate of biodiversity loss, and changes to the global nitrogen cycle.[3]

Academic scientists and pharmaceutical industry representatives described global health challenges related to pharmaceuticals for the diagnosis, prevention or treatment of rare diseases (orphan drugs), neglected diseases, a 30-year gap in development of new antibiotics, the increase in antibiotic resistant organisms, and the high cost of bringing a new drug onto the market. Additionally, there are inadequate incentives, collaborations, and strategies to overcome bottlenecks in academia and industry that hinder them from systematically tackling these global health challenges.

The picture is no brighter when considering the failure of partnerships and economic models to address global food security challenges. Workshop presenters described skyrocketing energy costs and waste in every step of the food production and consumption chain. Local and international causes of food insecurity and famine in sub-Saharan Africa create challenges for production, distribution and access to food. These include poverty, population growth, and inadequate access to land; lack of bridge loans, transport and storage facilities; climate change and drought, competition between food for local consumption and bio-fuel production for export; the removal of agricultural subsidies and the dependence of food prices on trading in international commodity markets for oil.

In the coming decades, industry and academia must, together, along with governments, scientific societies, and non-governmental and inter-governmental organisations, work to imagine and help to realise a more sustainable and equitable future. These sectors need to build a new era of partnerships that will bring together the resources and players necessary to reduce carbon dioxide emissions (as described by Arrhenius) and other greenhouse gases into the atmosphere, provide affordable health care, food security, adequate clean water supply, and meet energy needs, particularly in vulnerable regions of our planet.

Workshop on Academia-Industry relations, Sigtuna, Sweden, 22-25 November 2011

The ICSU Committee on Freedom and Responsibility in the conduct of Science organised the international workshop in collaboration with The Royal Swedish Academy of Sciences and The Royal Swedish Academy of Engineering Sciences. Appendices A and B contain the workshop agenda and the list of the participants respectively.

In keeping with ICSU's mission to "Strengthen International Science for the Benefit of Society," the event served to gather information and a variety of views from a global perspective on how academia (particularly scientists) and industry effectively can create productive partnerships. Participants examined how to build on the emerging era of new collaborations to address global challenges for mutual benefit and, ultimately, for the well-being of society. Scientific research is carried out in areas such as agriculture, biotechnology, information technology, medicine, and nanotechnology in both academia and industry, lead-

[3] J. Rockström, et al., 2009. "A Safe Operating Space for Humanity," *Nature*, 461, 472-475 (24 September).

ing to significant contributions to society. The cultures of academia and industry are quite different, and it became apparent over the course of workshop presentations and discussions that both sectors must work harder to collaborate more closely with each other and with government and other societal players to promote an environment of mutual respect and significantly increase the complementary exchange of valuable resources.

The workshop participants from academia and industry represented and presented widely different contexts in the global North and South. Together, participants sought to identify new opportunities for interaction and determine how to promote stronger and more trusting relationships.

The participants identified issues that are particularly relevant to freedom and responsibility in the conduct of science, as reflected in the remit of CFRS with regard to the Principle of Universality (Freedom and Responsibility) of Science (see Appendix C). The Principle highlights the importance of the free and responsible practice of science for scientific advancement and human and environmental well-being and stresses that: "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, recognising its benefits and possible harms."[4]

Participants described the priorities of industry in working with academia, such as intellectual contributions, technological skills, proximity to industrial hubs, and provision of competent and well-educated employees for industry. The group examined the roles of academic institutions in a rapidly changing world, including the necessity and ability of academia and industry jointly to bring major issues and potential solutions to policy makers and the public. One industrial participant reminded the group that "knowledge is at the top of the purpose of universities. In industry, knowledge is number two, and then only if you can beat your competitor with it."

In the course of the discussions over several days, a number of primary themes for successful collaborations emerged. They include intercultural understanding and the required trust, openness, transparency, and reciprocity between countries in the global North and South, and between academia and industry, as well as other partners. Knowledge and understanding of the differing cultures and codes of conduct under which academia and industry operate is vital to both, as is an understanding of when confidentiality or delays in publishing may be necessary and for how long, along with when such conditions may be problematic. In addition, to avoid any misunderstandings or dysfunctional partnerships, it was clear that legal agreements are essential early along the path toward serious cooperation.

The workshop devoted considerable time to discussion of issues of publication and patenting in the dissemination of knowledge, agreeing that both can promote openness and diffusion of knowledge and technology, but on different terms and conditions. Of particular importance to scientists and academic institutions is the ability to freely publish and disseminate research results. This enables scientists to exchange and use ideas openly, to receive recognition for discoveries, and to obtain critical review and testing of claims of new knowledge. Participants noted that publication of research results is also in the interest of society because it provides access to knowledge required to improve technical systems. They gave examples of the importance of access to knowledge to make health care more effective and less costly and to make transportation systems more efficient with less environment impact. In keeping with the Principle of Universality (Freedom and Responsibility) of Science, CFRS is mindful that the *freedom* to publish also comes with the corresponding *responsibility* to consider potential harm, such as when undertaking dual use research. That said, the freedom not to publish, for a limited time, can also be important because academic and private research often overlap and academics may need to take out patents on their research. It

[4] ICSU Statute 5, Principle of Universality (freedom and responsibility) of Science. http://www.icsu.org/about-icsu/structure/committees/freedom-responsibility/?icsudocid=statute-5 <15 January 2012>.

is important that patents give due recognition to the protection of investment of intellectual and economic resources while not blocking new research developments. The balance is a delicate one.

Complexity, successes, and failures of models for academia-industry interactions

The discussions helpfully drew out many of the complexities, successes and failures of current models and incentives for academia-industry relations through examples and case studies. Sketched briefly below are several examples that illustrate interactions, some promising and some that have failed to meet their objectives, which may help to guide future efforts to work together across sectors and point the way to new approaches that are needed to academia-industry relations.

Increasing complexity of models for successful academia-industry interactions

Participants discussed the evolution of models and implementation of practices for academia-industry interactions. Science and technology policy has been guided at times by simplistic models that assume innovations result from a linear process that starts with fundamental research, that forms the basis for applied research, that then leads to the development of new technologies and finally to commercialisation.

Workshop examples suggest that innovation cannot be planned top down. Rather, multiple routes to innovation exist, and successful approaches are conditioned by cultural and economic contexts. Participants described numerous capacity building initiatives that, to varying degrees, successfully brought technology and knowledge out of academia and into industry and society while also bringing industrial and societal needs and views into the agenda of academia. Examples included: the European Research Council "proof of concept" funding approach; the European Institute of Innovation and Technology building partnerships to tackle future information technology, climate change mitigation and adaptation, and sustainable energy; a nanomaterials partnership between industry and academia catalysed by the Peruvian Research Council (CONCYTEC); Swedish virtual research institutes with industrial participation on their boards to support the development of solar technologies, instrumentation and measurements; a Swedish partnership to develop low energy light emitting diode lamps; and experience with European Framework Programmes for Research and Technological Development.

When capacity and existing models are inadequate

Attention must be drawn to the assumption that innovations to meet the needs of society will emerge if only the right models for interaction among academic and industrial partnerships can be found. In some contexts, neither academia nor industry has sufficient capacity to work together for future-oriented innovation – the pressing realities of finding resources to meet core needs make this nearly impossible.

Many examples of insufficient capacity on both sides of needed partnerships between academia and industry exist in sub-Saharan Africa. The higher education sector is recovering from decades of neglect and underfunding, resources are often inadequate to provide core education functions, and the knowledge production capacity needed to drive new interactions is not available. The industrial sector primarily focuses on small and medium scale operations that target immediate and local needs. Where we find high technology producers and export-oriented manufacturers, their research and development infrastructure is often located elsewhere, without the geographical proximity that seems to be an essential ingredient for successful interactions.[4]

> *"Indeed, it may be stated with some force that without vibrant industry driven by the pressure to to increase productivity and lower costs in order to thrive in a fiercely competitive, usually export, market, the drive to innovate through the application of new knowledge and new technology remains weak, and recourse to knowledge institutions for support or collaboration is highly unlikely*."
>
> A. Sawyerr and B. Barry[5]

Breaking through this impasse requires a policy framework that supports systemic efforts by governments and international partners to strengthen both academic and industrial sectors, while at the same time providing incentives and opportunities for them to work together.

In some cases, the scale and scope of the grand challenges are so large that existing models for interaction prove completely inadequate to tackle them. Two case studies presented at the workshop illustrate this point: the pipeline gap for development of new antibiotics and the food security grand challenge.

Case Study: Academia-industry interactions in development of new antibiotics

The 30-year gap in the development of new antibiotics reflects one of the failures of current models and incentives of industry-academia interactions to address adequately a pressing global health challenge. The need for development of new classes of antibiotics is apparent globally, with different manifestations in the global North and South. Bacterial and parasitic diseases are a leading cause of death worldwide, especially in low-income countries. The World Health Organization (WHO) has identified antimicrobial resistance as one of the three greatest threats to human health.[5] Indiscriminate use of antibiotics and the rapid global spread of drug resistant bacteria like Methicillin-resistant Staphylococcus aureus (MRSA) that are often picked up by patients in hospital settings, have left health care professionals with few tools to fight infections, including antibiotic resistant organisms, known as "superbugs." Diminishing antibiotic options pose major threats to both the treatment of global diseases such as tuberculosis and to numerous advanced interventions that we currently take for granted, including surgery, cancer treatment, transplantation, and the care of premature babies.[5]

- *Infections caused by resistant microorganisms often fail to respond to conventional treatment, resulting in prolonged illness and greater risk of death.*
- *About 440,000 new cases of multidrug-resistant tuberculosis (MDR-TB) emerge annually, causing at least 150,000 deaths.*
- *Resistance to earlier generation antimalarial medicines such as chloroquine and sulfadoxine-pyrimethamine is widespread in most malaria-endemic countries.*
- *Highly resistant bacteria such as methicillin-resistant Staphylococcus aureus (MRSA) cause a high percentage of hospital-acquired infections.*
- *Inappropriate and irrational use of antimicrobial medicines provides favourable conditions for resistant microorganisms to emerge, spread and persist.*

World Health Organization, Fact Sheet No 194, Antimicrobial Resistance[6]

Despite the pressing need, pharmaceutical companies have neglected to invest substantial research and development capacity in the development of new antibiotics. Data was presented showing that antibacterials formed only 1.6% of the new molecular entities publicly disclosed in research and development programmes of the world's 15 largest pharmaceutical companies. The result? Between 1970 and 2000, no

[5] A. Sawyerr, B. Barry, 2010. African Higher Education and Industry: What Are the Linkages? Paper at the Annual World Bank Conference on Development Economics 2009, The International Bank for Reconstruction and Development / The World Bank.
[6] "Antimicrobial Resistance," World Health Organization, February 2011. Fact Sheet No 194, http://www.who.int/mediacentre/factsheets/fs194/en <15 January 2012>.

new antibiotic class was developed. In 2000, two new types of antibiotics reached the market; however, they had already been discovered in the 1980s. Clearly, the present innovative capacity within the industry is very low in this area.

What are the reasons for this widespread global failure of available partnerships to deliver solutions to address this challenge? The scientific problems are large and often underestimated, but are not insurmountable. The problems lie with existing business models and market constraints, for the following reasons. Return on investments in the industry is far greater from medicines for treatment of chronic diseases. Antibiotics are given in short courses, unnecessary use must be minimised, new products must be conserved, and the inevitability of development of resistance limits the duration of new drugs in the market place. The generic market for drugs has kept prices low. Clinical drug development is costly, and unclear regulatory demands on antibiotics have created uncertainty. Furthermore, consolidation in the pharmaceutical industry has led to fewer people in fewer companies doing antibiotic research, resulting in fewer partnerships with academia. This ripple effect leads to fewer career prospects after graduation for students working in academic settings, affecting the capacity of academic researchers to sustain research programmes in this area.

Workshop presenters called for a new era of business models in the pharmaceutical industry, built on global needs, which provide secure access and affordability as well as rational and responsible use. New models should be needs-driven, based on analysis of the failings of the antibiotic pipeline, and should stimulate research and development efforts to solve the scientific challenges needed to produce priority antibiotics. Incentives should de-link return on investment from sales and address controlled use and distribution, equitable global access, and affordability. Presenters and participants concluded that intervention from the public sector would be a necessary step in the new era of business model. The overall innovative capacity is low and not primarily located within the large pharmaceutical companies. It also has become apparent that drug sales will not be sufficient for investors to recoup their investment costs. Taking this further, the suggestion was also made that research and development of new antibiotics might be undertaken by publicly financed institutes and universities, with the actual manufacturing contracted out, but the intellectual property retained by the institutes.

> *"There is a need to change the present market system. We need new collaborative models … and they cannot be sales driven."*
>
> Workshop participant

Participants presented several examples of what the new era of partnership models might look like. In India, home of one-sixth of the world's population, and the third largest (by volume) producer of pharmaceutical products, the prototype of a new tripartite partnership involving government (Technology Information, Forecasting & Assessment Council, TIFAC) industry, and academia has been launched, with the goal of converting India into a drug discovery and pharmaceutical innovation hub. Issues essential to the successful development of this prototype for a drug discovery network include increased tax exemptions that allowed for much more rapid depreciation of investments, and the establishment of robust mechanisms to ensure value to all partners and build communication and trust. The models show potential for industry to tap the underutilised capacity of graduate programmes in the pharmaceutical sciences to work on problems important to the pharmaceutical industry.

> *"India is well poised to make the transition from a generic pharma powerhouse to an innovation giant."*
>
> Ranjit Shahani, President, Organisation of Pharmaceutical Producers of India

Presenters noted that in Europe, the Innovative Medicines Initiative (IMI) is an example of new ways of working together. IMI is a joint undertaking between the European Union and the pharmaceutical industry. It is Europe's largest public-private initiative, aiming to speed up the development of better and safer medicines for patients. The European Union's Directorate General for Health and Consumers recently announced an IMI research programme on new antibiotics, aimed at improving the efficiency of research and development of new antibiotics, provided there is an 'unprecedented open sharing of knowledge.'

> *"Finding the next generation of antibiotics is crucial if we are to stay ahead of the curve in the face of bacteria and other pathogens which are resistant to drugs. Investment in research and innovation will mean the best possible care for patients, and the Commission is working with industry and EU Member States to make this a priority."*
>
> Máire Geoghegan Quinn, European Commissioner for Research and Innovation

In parallel developments, the US-based Infectious Diseases Society of America recently called for a global commitment and partnerships to support the "10 x 20 Initiative," with a goal of developing 10 New Antibacterial Drugs by 2020.[7] This initiative has the broad goal of bringing together a coalition of "global political, scientific, industry, economic, intellectual property, policy, medical and philanthropic leaders to develop creative incentives that will stimulate new antibacterial research and development."[8]

Case Study: Academia-industry interactions toward global food security

The scale and magnitude of global food security challenges raises the stakes even further for finding solutions through successful deployment of partnerships from multiple sectors, including government and non-governmental organisations, academia and industry. Hunger and malnutrition are widely thought to be the single largest threat to world health. Addressing this challenge is a core part of the 1st UN Millennium Development Goal. At present, about one billion people are chronically malnourished, and their numbers are likely to increase as population grows by some two billion in the poorest countries. Malnutrition is the largest contributor to child mortality, as six million children die of hunger every year.[9] Food security is linked also to the infectious disease challenges in the previous antibiotics case study considered by the workshop, as malnutrition is a major factor in the onset of active tuberculosis and increases the risk of contracting other infectious diseases.

The challenges are multi-dimensional and complex. Adequate food production is only one crucial dimension of food security. Other elements include distribution and availability of food; economic, social, physical, and cultural access to food; and access to both water and land for local production.

Because of widespread global conflict, presenters highlighted availability of suitable land as a particular challenge. The rich and emerging countries want to ensure energy and food security, while low-income countries in sub-Saharan Africa and elsewhere have insufficient capacity to produce food for domestic use by the population. Since 2001, 227 million hectares of land in developing countries, mainly in Africa, have been transferred to external investors. Much of this land was taken from small producers with weak land rights and used to produce energy, often from sugar cane, which requires large amounts of water and energy. Because Oliver De Schutter, the United Nations special rapporteur on the right to food and others have drawn attention to this global conflict, steps recently have been taken to develop, through consultative processes, international guidelines and mechanisms to build corporate, social and environmental re-

[7] Infectious Diseases Society of America, 2010. Antibiotic resistance policy update, http://economist.inaar.com/ca_accounts/knowlegis/idsa/idsa_newsletter_MAR2010.html <15 January 2012>.
[8] "The 10 × '20 Initiative: Pursuing a Global Commitment to Develop 10 New Antibacterial Drugs by 2020," 2010. *Clin. Infect. Dis*. 50(8): 1081-1083 http://cid.oxfordjournals.org/content/50/8/1081.full <15 January 2012>.
[9] United Nations Office of the High Commissioner for Human Rights, 2010. *"The Right to Adequate Food,"* http://www.ohchr.org/Documents/Publications/FactSheet34en.pdf <15 January 2012>.

sponsibility. These involve mechanisms such as environmental and social impact assessments, processes of certification and codes of conduct. It was clear that mechanisms and guidelines are often inefficient and unenforceable in the current context. The dominant operating political economy framework suggests that modernisation will lead to win-win relationships. However, reports indicate that some companies use these guidelines when operating in the global North, but not in the South. Based on African examples, it appears that the regulatory framework is often difficult to enforce, and the newly formed alliances often alienate local players, especially small ones.

There is a need for more equitable business models guided by careful attention to developing shared values and trust to balance this frame. The needed knowledge exists, but it must be used in ways that are beneficial and must be shaped by underlying commitments to justice and environmental sustainability. Clearly, there is a strong need for academic institutions and industry to work together to understand the multiple value frames needed to address land issues related to food security. Emerging from experiences with land conflicts over food production have come suggestions that academia has a particular responsibility to frame the ethical issues that will guide the integrated political and economic analysis that might lead to the reassessment of values and a new sustainable framework for society.

Other elements of the food security challenge arise from the removal of agricultural subsidies and the dependence of food prices on trading in international commodity markets for oil that presently provides much of the energy needed for production, processing, and distribution. This has led to situations where local, sustainable food production cannot compete with food imported over long distances.

> *"In Zimbabwe there are big fat chickens imported from South America, but they also shrink in the cooking pot."*
>
> Workshop participant

The effects that climate change and inadequate access to water have on production are becoming increasingly important factors in the food security equation. Industry and academia, through partnerships, can develop new crops that will be more resilient to temperature, drought, and salinity. However, though these eventual new crops will help, food security cannot be achieved solely by the use of chemical and biotechnological solutions. It will be equally important to address socio-economic issues of distribution and waste.

In most developed countries, at least 30% of food is discarded after purchase, much of it while it is still edible. Even more strikingly, in less developed countries, some 50% of farm produce is lost before it reaches the market – for a combination of reasons including inadequate transport infrastructure, lack of storage facilities, and prices that fluctuate under the influence of commodity traders. Accurate monitoring and application of relatively inexpensive, low technology solutions such as the provision of cold storage could greatly reduce those losses. Furthermore, if higher technology solutions are rolled out through existing market-based structures, much of the potential gain in production may be lost by even higher wastage.

Envisioning the way forward

The workshop participants, from industry and academia in different parts of the world, came to the event all too well aware of the many and difficult grand challenges the world is facing. These challenges include population growth; sustainable development and ecological integrity; affordable, available, and accessible health care for all; equitable access to medicine to treat the most dangerous diseases, particularly for those in the least developed countries; clean water and energy; and climate change mitigation – as well as the often competing demands of each of these areas.

New technologies will unquestionably improve quality of life and longevity, as have technologies in the late 20th century – albeit primarily in wealthy nations. Three areas of huge promise, which "will transform healthcare in the 21st century," were noted. For example, "increased understanding of stem cells and associated technologies that develop will fuel the growth in the fields of regenerative medicine and synthetic biology. The human genome project is bearing fruit with personalised medicines that are making huge advances in cancer therapy. And, information technology is allowing medical information to be used in new and exciting ways and increasing the evidence base for medical practice."

Clearly, science, technology, innovation, and funding are essential in addressing such increasingly urgent and global problems. Also essential is continued investment in basic research, if we are to address both immediate and long-term problems and make the necessary scientific progress. But, it cannot be forgotten that, as one participant noted, science also contributes knowledge that is important for its own sake, yields practical applications, and enhances economic growth. But, how does one best produce the most value for science and ensure its fair and broad distribution, including in low-income regions of the world? "As well as being humanitarian, success or failure in this aim is critical to humanity's chances of survival on the planet," cautioned one participant. Science and industry increasingly must work efficiently and in partnerships so that scientific discoveries reach the people who need them at affordable prices, both locally and globally. In addition, such partnerships tend to solve interrelated but also cross-disciplinary problems that can be mutually reinforcing and beneficial.

But, for affordable new models for innovation to be built, government, industry, and academia must take on distinct roles and responsibilities.

Recent changes in universities from an economic perspective were discussed. A speaker from a technological university pointed out that "the size of the student market has increased, partly because of the rise of mass education worldwide; intense firm interaction, including open innovation such as contract research in instituted practices for several disciplines; and there has been a virtual explosion in terms of the number of research outlets, including new topics or disciplines and journals or conferences over the last decades."

> *"We have reached a point where sharing of resources on a finite earth is of the utmost urgency [if we are] to limit the combined impact of population and consumption on the environment. Solutions from science and technology are sought and eagerly anticipated. But, the solutions will only work under a sustainable economic structure."*
>
> Workshop participant

There was agreement that, to produce motivated, innovative researchers who will meet societal needs for discoveries and new scientific thinking, it is essential that starting at the undergraduate level, students are given a solid, creative and challenging basic education where freedom within academia is a priority, awareness of global challenges is integrated into the curriculum, and an inventive, creative spirit is fostered. Scientific research, increasingly, is multi-disciplinary and often involves international collaboration that is essential in understanding problems and their social, political and cultural contexts, as well as gaining a better understanding of the local and global environment.

The potential specialisation of individual academic institutions has increased, as has the ability of leading institutions to make significant progress in basic research. It was pointed out that if academic institutions are too "customer focused" they will be unable to maintain a stable foundation for knowledge creation and dissemination; yet, in a wide area of great societal significance, new research ideas or opportunities may only be discovered or developed while working closely and interacting with industry. After all, the audience was reminded, it is young people, close to the frontiers of knowledge, who often facilitate knowledge transfer because they have been trained in the innovative process by industry for future employment.

By establishing partnerships, academia brings credibility, cutting edge knowledge, new and interesting ideas, and intellectual and physical resources to the table while industry brings influence, training, technical know-how, significant research problems and financial resources. Such collaboration can involve small higher-education colleges cooperating with local enterprises that buy their technical development from others; or leading research universities with global networks that collaborate with major companies that have considerable research capacities. Together, in the view of one speaker, they benefit mutually from the dual use of knowledge. It reduces cost and partnerships make academics more aware of and responsive to industrial and societal needs. It also supplements industry research and development. But, for such partnerships to be successful, certain conditions must be met.

Conditions for constructive interactions between academia and industry for the benefit of society

After considering the various examples of academia/industry interactions provided by workshop participants, both positive and negative, the participants tried to identify what conditions are most important if science and industry, together, are to meet current challenges.

A study of such partnerships shows that it is essential for both sides to establish as much transparency as possible, along with equitable cooperation and respect for each other's differing work environments, objectives, ethics, and constraints. Goals must be defined on both sides and there must be flexibility and respect for confidentiality. Through such cooperation, both sides can increase access to human capacity and facilities and, over time, establish mutually valuable and sustainable relationships.

> *"Fashionable research and non-applicable applied research is destroying research at universities. Industry wants people who have really been dealing with challenges, and who know what we [industry] do not know. (...) Universities should remain the hot bed of new ideas, new messages, and new consequences."*
>
> Workshop participant

As already highlighted, there are, of course, regional and national accents to the dialogue about effective interactions between industry and academia. It was observed that with a global shift in health innovation to new regions, comes the urgent need to attend to the concomitant responsibilities, such as awareness of the risks of dual-use research and technologies, inherent in carrying such work. Research on the flu virus is a good example.

> *"The workshop of the world for health innovation is moving increasingly from the West to South East Asia"*
>
> Workshop participant

Academic institutions that establish relationships with industry can benefit greatly because industry provides necessary resources and facilitates the design and development of new and unique technologies that they can then deliver to the public and get necessary feedback. Industry can also provide employment and possible individual endowment funding from wealthy industrialists who get to know researchers and come to value working with academia.

That said, academia, in cooperating with industry, must maintain certain safeguards, including the freedom to pursue basic research ideas and to build up their general competencies. At the same time, there must be a willingness on the part of academia to consider the option of patenting or setting short-term exclusivity limits.

To pressure academic institutions to do applied research is not in the interest of industry. After all, academic institutions are not primarily about profitable business partnerships – though such partnerships may be a means to its ends; nor are they solely educational institutions – though education is a vital service to current and future generations. Academic institutions are, above all, in pursuit of intellectual challenge, independent thought and research, the discovery of imagined knowledge, becoming a trusted source of wisdom and, on occasion, whistle-blowers. Although intellectual freedom is appreciated by industry, collaboration can also frustrate industry because academic research can be slow and intellectual property rights can present a hurdle or insurmountable barrier. Industry often does not understand the significance of the need by scientists in the academic sector to freely publish their research results. On the other hand, there must be a willingness on the part of academia to consider the option of patenting or setting short-term exclusivity limits if they are to establish viable partnerships.

For its part, industry can benefit from working with the academic sector because they share visions that can help industry to be in "the frontline looking over the horizon." Industry also stands to benefit from such partnerships because research and development need multiple approaches, including fundamental research, to understand the phenomena behind the technology.

One participant said that while innovation is essential, contrary to popular belief, it does not always follow a linear model, which is described as a series of steps, consisting of basic research, applied research, development, and then mass production. Participants suggested that this misperception of a linear model often leads to misguided science and technology policies. In fact, the linear model often does not work for innovation, as the activities take place in parallel. Often discoveries are made in basic research, which can rapidly be transferred into industrial developments and thus 'short circuit' the linear model. The effect of this "short circuit" model can be to reduce industrial costs and improve the quality of the products developed.

Asymmetrical aspects of academia and industry

Also discussed were the differing work cultures, objectives, values, and ways of moving forward, as well as why and how these elements affect the interactions between the academic sector and industry. Most academic institutions serve, to varying degrees, different markets – including research, education, business, and society. All four markets have expanded greatly in recent years. One workshop participant asked whether there is an inherent trade off in academic institutions trying to serve all of these markets. For example, how do individual academics perceive these roles as they relate to their innovations? Also noted was that, within the different market categories, there are tensions with respect to how encompassing the academic sector (and its students) might be or how narrowly institutions might specialise.

In addition, academic institutions are more autonomous vis-à-vis national governments; despite frequent political pressure to get the technology and knowledge they generate "out" to benefit society and industry. To overcome some of these imbalances and increase understanding, the academic sector should consider offering to industry such opportunities as visiting professorships, service on boards contributing to the formulation of curricula, guest speaker slots, advice on applications of research results, etc. Industry, for its part, could offer academics sabbaticals and secondments with opportunities for business challenges, and consultation on how to move basic research to commercial applications.

The workshop only scratched the surface of many interesting and important dimensions to academia-industry scientific interactions. We conclude by highlighting two areas in which further and on-going dialogue may be helpful.

Freedom and responsibility (Principle of Universality of Science) as a framework for academia-private sector science interactions

We suggest that the framework of ICSU's Principle of Universality (freedom and responsibility) of Science provides a strategic vantage point from which to view interactions among academia and industry and the other entities with which they both engage for the benefit of society. In a symmetrical way, the Principle balances the importance of the freedom to practice science with the responsibility to ensure that scientific work is carried out with "integrity, respect, fairness, trustworthiness, and transparency," along with the larger responsibility to consider both the benefits and possible harms of science. The overarching consideration highlighted by both the Principle of Universality of Science and by ICSU's mission is to ensure that the practice of science focuses on human and environmental well-being. As the case studies introduced at this workshop show, if we are to find solutions to societal grand challenges and achieve equitable access to the benefits of science, a new era of interactions and models is essential. It should prove helpful to consider further how the balance between freedom and responsibility articulated in the Principle of the Universality of Science might serve as a framework to inform and guide the new era of interactions and models. Implicit in those freedoms and responsibilities is the responsibility of scientists to communicate with citizens and organisations, as well as industry, and to influence politicians, to raise awareness of societal challenges and the promise of academia-industry partnerships in contributing solutions.

An on-going role for the International Council for Science?

As a credible voice for global science, ICSU is in a unique position to guide and coordinate the efforts of its diverse scientific unions and national members to work together with industry toward solutions to global challenges. We suggest that ICSU continues to give priority to ensuring that grand challenges, particularly including those that require equitable sharing of resources on a finite planet, are at the forefront of the agenda for science interactions between academia and industry. ICSU also can help to ensure that the freedom to responsibly pursue science is maintained and appreciated; that on-going, open dialogue among stakeholders is maintained about the most effective ways to use the tools of science to benefit society; and that due recognition is given to the investment of intellectual and economic resources. Academia-industry interactions contain inherent tensions between the need for open access to scientific data and intellectual property rights. ICSU can play a role in ensuring open and on-going communication and dialogue between sectors, and in advocating for the importance of "equitable access to data, information, and other resources for research" (Principle of Universality of Science). Such dialogue can fruitfully explore questions such as the following:

- What is the role for governments, and non-governmental and intergovernmental organisations in working with academia and industry on global challenges?
- What are the future benefits and risks of openly sharing scientific data?[10]
- How does one balance the digital ear's openness against intellectual property rights?
- What responsibility should individual scientists, academic institutions, industry, and the research funders have for open data?
- How can academia achieve a balance between fundamental 'blue sky' research and thematic, applied research? What is the role for industry, government, and funders of research in maintaining the appropriate balance?
- How can we nurture industrial-academia interactions in settings where capacity is severely limited, especially in the global South?[11]
- How can we encourage scientific union members to take a more active role in this domain?

[10] Grady, Denise; Broad, William J., 2011. "Fearing Terrorism, U.S. asks Journals to Censor Articles on Virus" *The New York Times* 20 December. For the first time ever, a government advisory board is asking scientific journals not to publish the details of certain biomedical experiments, for fear that the information could be used by terrorists to create deadly viruses and touch off epidemics.

[11] Butler, Declan, 2011. "Egypt's researchers hungry for reform," *Nature* 8 February: "Egyptian universities lack intellectual-property policies and mechanisms to create spin-off companies. (...) there is minimal collaboration between industry and academia and an absence of industrial support for science research. This is mainly because industries in Egypt, including the pharmaceutical industry, are not based on innovation but on licensing technologies from multinational companies. Biotechnology and nanotechnology industries are currently almost non-existent in Egypt" (quotes from Hassan Azzazy, chemist and associate dean for graduate studies and research, American University in Cairo.)

Appendices

Appendix A: Programme of the International Workshop on Private Sector – Academia Interactions

Tuesday, 22 November

Opening
Prof. Bengt Gustafsson, Uppsala University & Chair of CFRS

Session 1: The research landscape today and ahead
Moderator: Dr Carthage Smith, Deputy Executive Director, International Council for Science ICSU

The roles of the universities in a changing world
Dr Magnus Holmén, Senior Lecturer, Chalmers University of Technology
New knowledge for industry – recent developments and means
Sir William Castell LVO, Chairman of Welcome Trust
New knowledge for the world
Prof. John Sulston, Chair, Institute for Science, Ethics and Innovation, University of Manchester & Member of CFRS
To promote the spirit of inventing
Dr Shunpei Yamazaki, Semiconductor Energy Laboratory SEL
Basic research and industrial innovation
Prof. Jens Rostrup-Nielsen, former Director of R&D Division, Haldor Topsø A/S

Session 2: Contracted research, joint ventures and other collaborations
Moderator: Dr Carthage Smith, Deputy Executive Director, International Council for Science ICSU

Example 1: ***Energy & materials***
Prof. Walter Estrada, Universidad Nacional de Ingenieria
Prof. Sven Kullander, Uppsala University & Chairman, Energy Commission, The Royal Swedish Academy of Sciences RSAS
Prof. Lars Samuelson, Director, Nanometer Structure Consortium, Lund University

Wednesday, 23 November

Moderator: Prof. Staffan Normark, Permanent Secretary, RSAS

Example 2: Drug & pharmaceutical innovations
Ingrid Petersson, EU Science Relations and Collaborations Leader R&D, AstraZeneca
Dr Vipin B. Gupta, Director, BR Nahata College of Pharmacy & BRNSS Contract Research Center
Prof. Otto Cars, Chairman, ReAct - Action on Antibiotic Resistance & Uppsala University

Example 3: Food security
Prof. Maria Elisabetta Guerzoni, Faculty of Agriculture, University of Bologna
Prof. Sara Feresu, Director of Institute of Environmental Studies, University of Zimbabwe
Prof. Kjell Havnevik, Nordic Africa Institute

Thursday, November 24

Session 3: To promote innovations
Moderator: Prof. Björn O. Nilsson, President, IVA

Discussion: To stimulate innovations and the use of them
Dr Alexander von Gabain, Chairman, European Institute of Innovation and Technology

Dr Horst Soboll, Research Policy Consultant to the European Commission
Ulf Wahlberg, Vice President, Industry and Research Relations, Ericsson

Session 4: Rights and ethics
Moderator: Prof. Akilagpa Sawyerr, Vice President of Ghana Academy of Arts and Sciences & Member of CFRS

Discussion: Ethics of innovation and business – when different value systems meet
Prof. Mats G. Hansson, Director, Centre for Research Ethics and Bioethics, Uppsala University
Prof. Johan Kleman, Vice Dean of the Faculty of Science, Stockholm University & NEO Collaboration
Prof. Huanming Yang, President, Beijing Genomics Institute-Shenzen BGI

Discussion: IP protection, confidentiality, and openness in science
Prof. Bronwyn H. Hall, Department of Economics, University of California, Berkeley
Prof. Marianne Levin, Director, Institute of Intellectual Property Law, Stockholm University
Ms. Susanne Ås Sivborg, Director General, Swedish Patent and Registration Office

Session 5: The roles of mediators and civil society
Moderator: Prof. Ashima Anand, Delhi University & Member of CFRS

Example 1: The European Framework Programmes for Research and Development
Prof. Anders Flodström, Executive Committee member, European Institute of Innovation and Technology
Dr Rüdiger Klein, Executive Director, ALLEA
Wolfgang Polt, Director, Centre for Economy and Innovation Research, Joanneum Research

Example 2: Pharmaceutical policies and the roles of different stakeholders
Dr Edward Abrahams, President, Personalized Medicine Coalition
Prof. Maria Anvret, Senior Advisor, The Sahlgrenska Academy, University of Gothenburg

First discussion of conference statement
Convened by Prof. Bengt Gustafsson, Uppsala University & Chair of CFRS

Friday, 25 November
Session 6: What could we learn from each other?
Moderator: Prof. Bengt Gustafsson, Uppsala University & Chair of CFRS

Discussion: What could we learn from each other?
Prof. Lena Gustafsson, Vice Chancellor, Umeå University
Prof. Sylvia Rumball, Massey University & Member of CFRS
Prof. Akilagpa Sawyerr, Vice President, Ghana Academy of Arts and Sciences & Member of CFRS
Dr Jan-Eric Sundgren, Senior Vice President, Volvo
Prof. Lars Wärngård, Head, Division of Manufacturing and Working Life, VINNOVA

Discussion: Final discussion of conference statement & Closure

Appendix B: Participants at the international workshop

Edward **Abrahams**, President, Personalized Medicine Coalition PMC, United States
Olov **Amelin**, Director, Nobel Museum
Ashima **Anand**, Member, ICSU CFRS & Biomedical Research Scientist, V.P. Chest Institute, Delhi University, India
Maria **Anvret**, Senior Advisor, Research and External Relations, The Sahlgrenska Academy, University of Gothenburg, Sweden
Susanne **Ås Sivborg**, Director General, Swedish Patent and Registration Office SPRO, Sweden
Lars **Bolund,** Beijing Genomics Institute-Shenzhen BGI, China
Otto **Cars**, Chairman, ReAct – Action on Antibiotic Resistance & Uppsala University, Sweden
William **Castell**, LVO, Chairman, The Wellcome Trust, United Kingdom
Carol **Corillon**, Member, ICSU CFRS & Director, Committee on Human Rights of the US National Academy of Sciences NAS, United States
Yajun **Deng**, Beijing Genomics Institute-Shenzhen BGI, China
Walter **Estrada**, Peruvian Academy of Sciences & Peruvian Society of Physics, Universidad Nacional de Ingenieria UNI, Peru
Xiaoli **Feng**, Beijing Genomics Institute-Shenzhen BGI, China
Sara **Feresu**, Director, Institute of Environmental Studies, University of Zimbabwe, Zimbabwe
Edvard **Fleetwood**, Secretary General, Sweden-Japan Foundation, Sweden
Anders **Flodström**, Executive Committee member, European Institute of Innovation and Technology EIT, Sweden
Karl **Grandin**, Director, Royal Swedish Academy of Sciences RSAS, Sweden
Maria Elisabetta **Guerzoni**, Faculty of Agriculture, University of Bologna, Italy
Vipin B. **Gupta**, Director, BR Nahata College of Pharmacy, India
Bengt **Gustafsson**, Chair, ICSU CFRS & Uppsala University, Sweden
Lena **Gustafsson**, Vice-Chancellor, Umeå University, Sweden
Bronwyn H. **Hall**, Department of Economics, University of California, Berkeley, United States
Mats G. **Hansson**, Director, Centre for Research Ethics and Bioethics, Uppsala University, Sweden
Kjell **Havnevik**, Nordic Africa Institute, Sweden
Magnus **Holmén**, Senior lecturer, Department of Technology Management and Economics, Chalmers University of Technology, Sweden
Karin **Jonsell**, Coordinator and Communications Officer, The Royal Swedish Academy of Sciences RSAS, Sweden
Rüdiger **Klein**, Executive Director, All European Academies: European Federation of National Academies of Sciences and Humanities ALLEA, The Netherlands
Johan **Kleman**, Vice Dean of the Faculty of Science & Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden
Sven **Kullander**, Chairman, Energy Committee, The Royal Swedish Academy of Sciences RSAS & Uppsala University, Sweden
Marianne **Levin**, Director, Institute of Intellectual Property Law IFIM, Stockholm University, Sweden
Alf **Linderman**, Director, The Sigtuna Foundation, Sweden
Peter **Mahaffy**, Member, ICSU CFRS & The King's University College, Canada
Björn O. **Nilsson**, President, The Royal Swedish Academy of Engineering Sciences IVA, Sweden
Katarina **Nordqvist**, Research Director, Nobel Museum, Sweden
Staffan **Normark**, Permanent Secretary, The Royal Swedish Academy of Sciences RSAS, Sweden
Ingrid **Petersson**, EU Science Relations and Collaborations Leader R&D, AstraZeneca, Sweden
Roger **Pfister**, Executive Secretary, ICSU CFRS & Head International Cooperation, Swiss Academies of Arts and Sciences, Switzerland
Wolfgang **Polt**, Director, Centre for Economy and Innovation Research, Joanneum Research Forschungsgesellschaft mbH, Austria

Jens R. **Rostrup-Nielsen**, retired R&D Director & Affiliate professor, KTH Haldor Topsøe A/S & Scientific Council at ERC, Denmark
Sylvia **Rumball**, Member, ICSU CFRS & Massey University, Palmerston North, New Zealand
Lars **Samuelson**, Director, Nanometer Structure Consortium, Solid State Physics, Lund University, Sweden
Akilagpa **Sawyerr**, Member, ICSU CFRS & Vice President, Ghana Academy of Arts and Sciences, Ghana
Carthage **Smith**, Deputy Executive Director International Council for Science ICSU, France
Horst **Soboll**, Consultant R&D and Innovation HS Consulting, Germany
John **Sulston**, Member, ICSU CFRS & Institute for Science, Ethics and Innovation, University of Manchester, United Kingdom
Jan-Eric **Sundgren**, Senior Vice President, Public and Environmental Affairs, Volvo Group, Sweden
Peter **Sundin**, Head, International Science Programme ISP, Uppsala University, Sweden
Uno **Svedin**, Stockholm Resilience Centre, Stockholm University, Sweden
Ulf **Wahlberg**, Vice President, Industry and Research Relations, Ericsson AB, Sweden
Alexander **von Gabain**, Chairman European Institute of Innovation and Technology EIT, Hungary
Lars **Wärngård**, Director, Head of the Division of Manufacturing and Working Life, VINNOVA, Sweden
Shunpei **Yamazaki**, President, Semiconductor Energy Laboratory SEL Co., Ltd., Japan
Huanming **Yang**, President, Beijing Genomics Institute-Shenzhen BGI, China

Appendix C: Universality of Science

The universality of science in its broadest sense is about developing a truly global scientific community on the basis of equity and non-discrimination. It is also about ensuring that science is trusted and valued by societies across the world. As such, it incorporates issues related to the conduct of science; capacity building; science education and literacy; access to data and information and the relationship between science and society. There are a number of ICSU activities and Bodies addressing these issues. Underpinning this broader concept of universality is the Principle of Universality of Science (ICSU Statute 5, below), which is more narrowly focused on the freedoms and responsibilities of science. Adherence to this Principle is a condition of ICSU membership. The policy Committee on Freedom and Responsibility in the conduct of Science (CFRS) serves as the guardian of the Principle and undertakes a variety of actions to defend scientific freedoms and promote integrity and responsibility.

The Principle of Universality (freedom and responsibility) of Science

The free and responsible practice of science is fundamental to scientific advancement and human and environmental well-being. 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, recognising its benefits and possible harms.

In advocating the free and responsible practice of science, ICSU 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.

N.B. This wording of Statute 5 was approved by the 30th ICSU General Assembly in Rome in September 2011.