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Promoting International Scientific Cooperation: the Role of Scientific Societies

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Abstract

Scientific collaboration yields many advantages, especially in fields that require interdisciplinary approaches, as it fosters the sharing of knowledge and resources and is essential for the implementation of complex projects. The concept of scientific internationalism emerged around the 1900s, emphasizing that science surpasses national boundaries and promotes global peace and collaboration. International scientific cooperation is halted by geopolitical tensions and conflicts, such as World War II and the Cold War. Nevertheless, many examples show that scientific collaboration can surpass conflicts and bring scientific and society development, such as in the cases of the Tick-borne Encephalitis vaccine, the Apollo-Soyuz test project and more recently the international endeavour for COVID-19 vaccine development. In this contest, UN and WHO have an imporant role to promote peace and scientific cooperation, examplified by the 16th Sustainable Development Goal, to "Promote just, peaceful and inclusive societies".

This review aims to assess the available literature regarding international scientific collaboration and the role of scientific societies in promoting scientific cooperation.

Scientific societies have proved to be pivotal in bridging cultures and promoting international cooperation. Apart from the historical example of the International Institute for Applied Systems Analysis, which showed an important cooperation between Western and Eastern countries during the Cold War, the scientific society European Biotechnology thematic network Association (EBTNA) has international scientific cooperation as one of its critical goals.

Scientific societies such as EBTNA will be pivotal in promoting international scientific cooperation and fostering international activities and scientific research.

Keywords: bioethics, scientific collaboration, scientific societies, EBTNA

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Introduction

Scientific collaboration is as old as science itself. In the ancient world, scholars flocked to academic centres of learning such as Alexandria and its great library, later to Bologna, Montpellier and Paris. In the mid 19th century Germany became the scientific capital of Europe and scholars in all fields of science studied in Germany. Germany was the first country to have universities focused on research and scholarship rather than mere learning from the texts of Aristotle and Galen. The modern research University, as founded in Berlin by William von Humboldt, soon became the model for universities all over Europe and America and continues to be the model today [1], including the USA with Johns Hopkins University, setting a national trend witnessing research universities there flourishing and attracting the brightest scholars (brain drain). Long before von Humboldt's university reforms in Germany, the first Scientific Societies in Europe, such as The Royal Society of London (founded in 1660), Nationale Akademie der

Wissenschaften in Germany (founded in 1652), the *Accademia delle Scienze dell'Istituto di Bologna*) in Italy (founded in 1690) and the *Academie des Sciences* of Paris (founded in 1666), were important meeting places for scientists where they often published their proceedings. In addition to Scientific Societies, scientists met and discussed their work in salons and soirees from the 17th to the 19th century, with an upsurge in Paris during the Enlightment [2].

The benefits of collaboration

Collaboration is a boon to scientific research in every branch of science, such as brain sciences and rare diseases studies, and cumulative knowledge is crucial for scientific development [3,4]. Most labs do not have all of the equipment necessary to conduct interdisciplinary research, nor are they built that way, exceptions are however found in such labs as those developing bioengineering projects, such as biosensors. Collaboration is essential to develop ideas and to complete complex projects [3,5,6], and there is even an emerging field of research on "the science of team science" [7]. One finding from this research is that spatial proximity increases collaboration [8]. But what happens during a pandemic when travel to labs in other countries and even face-to-face meetings are not possible? The ability to have online meetings means that collaborations can continue, but they are of a different nature. Although there is the suggestion that virtual meetings reduce creativity [9], it is possible to collaborate internationally via online meetings, as illustrated by the collaborative book "*Body, Brain, Behavior: Three Views and a Conversation*" [10], which explores the use of conversation as a conduit for scientific thought and development [11]. International scientific cooperation should be based on specific principles such as integrity, transparency, and reciprocity, which can allow breakthrough discoveries that will help humanity meet global challenges (https://www.aps.org/programs/international/research-collab.cfm). University and research institutions should support intercultural communcation also through specific workshops and trainings, in order to enhance collaboration and make academic research flourish [12]. Cross-border collaboration, which include sharing data and best practices, as well as discussion at a global level, is essential to develop new knownledge and augment science social impact (https://www.scienceeurope.org/our-priorities/cross-border-collaboration/). Scientific collaboration and knowledge discovery can be enhanced by effective search and sharing of raw data and findings by international scientists. This can be achieved by projects such as "Footprints", which will introduce a platform that integrates social media, AI, and data-sharing tools to transform scientific research. The platform will also support typical social media functions alongside specialized research tools, including a certified lab notebook (https://footprints-b291f.web.app/ (tentative)).

Scientific internationalism

The concept of scientific internationalism emerged around the 1900s, emphasizing that science transcends national boundaries and furthers global peace and collaboration. This idea gained traction through global scientific and technological displays, such as universal expositions [13]. However, the progress of scientific internationalism was interrupted by two World Wars and the subsequent Cold War, which significantly diminished scientific cooperation among countries that were not allies. Indeed, a number of historical studies have shown that military concerns and Cold War geopolitics had a huge impact on many domains of science, including biomedicine, altering their direction and scope. The extent of this impact is only beginning to emerge from historical studies, but many examples can be revealed on how scientific cooperation crossed national borders [14] (https://www.unesco.org/en/scientific-research-cooperation-why-collaborate-science-benefits-and-examples).

One important example of scientific collaboration between unallied countries during Cold War comes from the development of the Tick-borne Encephalitis vaccine. In the late 1930s, Soviet science displayed strong isolationist tendencies, although these began to diminish following the end of World War II (WWII), enabling increased interactions between Soviet and Western academics, particularly in fields like the natural sciences and virology. Collaborative efforts, such as in the development of the Tick-borne Encephalitis vaccine, involved the USA, UK, and the Soviet Union, leading to safer and more effective vaccines. The adoption of common scientific languages, with Soviet research being published in more accessible German and English language academic journals, allowed for international recognition and enhanced international scientific cooperation between Soviet and Western blocks [14].

Another iconic historical example of scientific cooperation during wartime is the Apollo-Soyuz test project. Conducted in the 1970s, this joint venture between the United States and the Soviet Union facilitated the launch and safe return of spacecraft and astronauts from both nations. The Apollo-Soyuz test project served as a precursor to the 1994 space agreement between the USA and Russia, establishing a foundation for future joint projects in space exploration, and also allowing astronauts to train in each other's countries [15]. International scientific cooperation between USA and the countries of the former Soviet Union is also exemplified by the International Science and Technology Center (ISTC), an intergovernmental organization that work with governments, international bodies, and private sector companies, providing scientists previously engaged in Soviet weapons programs with opportunities to apply their expertise to peaceful endeavors, including cancer research and environmental applications (https://clintonwhitehouse4.archives.gov/WH/EOP/OSTP/html/00426_7.html).

A more recent example comes from USA-China collaboration during the COVID-19 pandemic. Scientific cooperation between USA and China started in 1972 with the foundation of the first US–China joint committee for

cooperation in medicine and public health. Over four decades, US and Chinese collaboration in health research increased, but in the last decade other factors, especially economic and security issues, reopened tensions between the two countries [16]. As reported in *Nature*, international collaborations, such as the one between the USA and China, are under the pressure of geopolitical tensions, and were complicated by the coronavirus pandemic [17]. Indeed, USA and China argued over several COVID-19 related issues, including the origin of SARS-CoV-2 virus, but despite these difficulties, international scientific collaboration is essential for continued scientific progress [17,18]. This is evident in the Nature Index journals, where the USA and China, despite existing geopolitical tensions, are each other's most important collaborative partners. The USA and China have cooperated on several discoveries in various scientific fields, from astronomy to cancer, showing how strong international scientific collaboration can be beneficial to society [19]. During the COVID-19 pandemic, scientific research collaborations significantly accelerated the dissemination of crucial findings and fostered a dynamic global exchange of knowledge, particularly in studying the SARS-CoV-2 virus' genomic composition and protein structures [16,17,20].

In the study of COVID-19, new biotechnologies and their interdisciplinary methods have significantly advanced the comprehension of molecular bases and the creation of various diagnostic and therapeutic options [21]. International cooperation has been crucial in the medical biotechnology research related to COVID-19 [22]. Biotechnology is an emerging and rapidly advancing scientific field that spans numerous research areas, including healthcare, agriculture, and industrial applications [23]. Biotechnology is defined by its interdisciplinary nature and the collaboration between researchers from various countries and academic backgrounds [24]. Collaboration in biotechnology usually involves universities as well as public research institutions and industry, where it fosters growth and the establishment of centers of excellence [23,25]. Partnerships between the public and private sectors are mutually beneficial: academia can transfer knowledge to the industrial domain, while companies gain access to complementary scientific insights to improve their innovations. This synergy has yielded significant advancements in several biotechnology areas, including genomics, synthetic biology, healthcare diagnostics, and bioinformatics [23,25].

The role of WHO and UN in promoting peace and scientific cooperation

In the area of international cooperation, the World Health Organization (WHO) has played a major role in shaping research agendas in the biomedical sciences in the post WWII era. Since it's foundation in 1946, the WHO has focused on public health and on genetic studies of human populations, which became an important contributor to fostering international relations, cooperation, and development. The post-war period emphasized the belief that every individual deserves the highest attainable standard of health as a foundational step toward ensuring peace and security [26]. Technologies like penicillin and vaccines, developed during WWII, were recognized as vital tools in advancing global public health [26].

The founding principle of the WHO was that "disease knows no frontiers," underscoring the need for coordinated international responses to health challenges. Although Cold War tensions initially hindered the participation of the Soviet Union and Eastern bloc countries in the WHO, the organization eventually succeeded in harmonizing international efforts to enhance global health outcomes [26]. Furthermore, the United Nations (UN), of which WHO is a part, recently launched the Sustainable Development Goals initiative. These goals are a universal call to action with the aim to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030 (https://www.un.org/sustainabledevelopment/) [27,28]. Among these, the 16th Goal aims to "Promote just, peaceful and inclusive societies." It highlights the detrimental impact of armed violence on a country's development, which can stifle economic growth, exacerbate longstanding community hardships (https://www.un.org/sustainabledevelopment/), and reduce scientific development and collaborations.

Several international scientific initiatives and centers under aegis of United Nations have been established over the last 50 years. They have been contributing to the peaceful and sustainable development of science in sectorial scientific fields promoting the international collaboration between industrialized and developing countries. A successful example is International Centre for Theoretical Physics (https://www.ictp.it/) founded by Nobel laureate Abdus Salam in Trieste, Italy in 1964. The Centre is acting with the support of UNESCO, IAEA and Italian government. This initiative was followed in 1988 by the establishment of the International Center for Genetic Engineering and Biotechnology (ICGEB) as a special project of UNIDO. ICGEB became an autonomous intergovernmental organization in 1994. It operates more than 45 state-of-the-art laboratories in Trieste, Italy, New Delhi, India, and Cape Town, South Africa, and forms an interactive network in the field of genetic engineering and biotechnology with nearly 70 member states, in accordance with the goals of sustainable global development of the United Nations system. (www.icgeb.org). However, a peaceful international collaboration is increasingly hampered by international conflicts and wars which can cause researchers to flee countries in crisis and boycott research from a particular geographical area. Despite this, international scientific societies in times of peace and war are crucial for discussing, exchanging ideas, and cultivating healthy and objective thinking [29–31]. Science and scientific societies can promote international collaboration, reducing boundaries and helping to create just, peaceful and inclusive societies.

Legal issues related to the international scientific collaboration

As mentioned above, the international scientific collaboration has led to the advances in the global knowledge and to the increase of our understanding of the world. It has also helped

humanity to tackle global challenges. However, the research progress brings at the same time societal, ethical and legal problems which are often neglected or underestimated. On the one hand, there is a constant effort to develop and harmonize the global legal framework related to the international scientific cooperation, patent rights, free exchange of knowledge and scientists, etc. This applies especially in Europe where European Union is for years active in these process of harmonisation [32]. On the other hand, there are tendencies of de-internationalization [33], but, more seriously, there are efforts in many countries to create legal barriers that make international cooperation more difficult or hindered. Among these efforts, there is a tendency to make the exchange of scientists more difficult (e.g. by restricting the visa policy, etc.) and to control and restrict the activities of scientific societies and scientific-oriented non-governmental organizations. Here, the international scientific societies, such as the European Biotechnology Thematic Network Association (EBTNA), are expected to play an important role also in promoting legal framework leading to the efficient international scientific collaboration and thus to the peaceful and open society.

In addition to these challenges, the protection of personal data and the transfer of biological materials between countries for scientific purposes have become critical issues. The implementation of personal data protection laws, such as the General Data Protection Regulation (GDPR) in Europe, has introduced stringent requirements for the handling of personal data in research. Although these regulations are essential to ensure the privacy and security of individuals' data, they also add complexity to international scientific collaboration, and they must be addressed by researchers worldwide. Moreover, different countries often have varying regulations and requirements for the import and export of biological specimens, which can create significant hurdles for international research projects. Standardized protocols and mutual agreements are crucial to facilitate the exchange of biological materials while ensuring compliance with national and international regulations.

A concerted legal framework is also important to respect intellectual property rights and to harmonise local laws and regulations with the international law. The legal framework should reflect not only fundamental scientific principles, but also highlight professional conduct and ethical behaviour. This is particularly relevant for research fields such as biotechnology and genetics, where hot ethical issues are being already tackled by MAGI International Bioethics Group in collaboration with EBTNA.

The role of scientific societies and EBTNA in bridging cultures and promoting international cooperation

A significant contribution to peace and international bridge building can come from international scientific societies and institutes. A notable historical example is the founding of the International Institute for Applied Systems Analysis (IIASA) in 1972. Its primary aim was to facilitate collaboration between the United States and the countries of the Soviet bloc, transcending political barriers [34]. Over a period spanning 17 years during the Cold War, and continuing for nine additional years thereafter, IIASA facilitated cooperation among nations that were not traditional allies. This collaboration occurred largely free from the influence of day-to-day politics, resulting in significant interdisciplinary contributions in fields such as energy, agriculture, ecology, and the study of population growth and aging. IIASA demonstrated that scientific collaboration could yield substantial benefits not only for the participating countries but also for the global scientific community [34]. Another prominent example is the International Brain research Organization (IBRO), founded in 1961. IBRO is the global association of neuroscience societies established in 1961 that aims to promote and support neuroscience around the world through training, education, research, outreach and engagement activities, and the publication of two journals, Neuroscience and IBRO Neuroscience Reports (https://ibro.org/).

Another important example is the EBTNA (https://www.ebtna.eu/). The EBTNA was established in 1996 as a biotechnology collaboration within the framework of the European Union Project under the leadership of Professor Mariapia Viola-Magni. It offers both academic and industrial projects that help link science with the biotechnology industry. Afterwards, it was registered in 2007 and transformed into the European Biotechnology Thematic Network Association (https://www.ebtna.eu/). Its core objectives include implementing and supervising skill and knowledge assessment programs in the sciences, particularly biotechnology; undertaking educational and training programs using innovative approaches; providing consultancy or assessment services as educational programs; certifying achievements under appropriate conditions; collaborating with professional associations to further its goals; and extending biotechnology education beyond national and European borders [35]. The EBTNA gathers experts from all over the world, including but not limited to Europe, Turkey, Albania, UK, Israel, India, and USA, reflecting its broad international scope (https://www.ebtna.eu/). In addition, the EuroBiotech School Project was initiated to internationalize the activities of the Department of Biotechnology and to provide students with a valuable education in advanced biotechnology and to design a new Master's Program that is multilaterally recognized by cooperating universities in Europe (https://www.ebtna.eu/). The EBTNA acknowledges biotechnology and life sciences as pivotal industries of the 21st century, essential for improving health, feeding growing populations, and meeting daily needs, but importantly, education of international graduates remains a primary goal for EBTNA, emphasizing the critical importance of training the next generation of biotechnologists. Moreover, EBTNA has addressed the ethics of biotechnology, an essential subdiscipline of bioethics that examines the ethical implications of various biotechnological research areas and their applications. Indeed, like all scientific endeavors, biotechnology presents both potential benefits

Table 1. Strenghts, challenges and opportunities for scientific societies.

Strength/Challenge/Opportunity	Description
Interdisciplinarity	Scientific societies promote and foster interdisciplinary and International research collaboration.
Inclusion	Scientific societies can welcome minorities and stimulate international communication, creating a more welcoming scientific community.
Reliable information	Scientific societies can address the growing spread of false of misleading information (fake news) with reliable and scientifically supported information. Encouraging open science practices and enhancing data sharing protocols can improve research transparency and collaboration efficiency.
Training	Training courses and seminars help fill the gaps in university degrees training, which is often focused on theoretical and basic research, rather than practical applications.
Global networks	Scientific meetings can improve networking to build an engaged scientific community augmented by virtual meetings and online interactions.
Fundraising	Scientific societies can support young researchers, trainings, and research projects, especially in developing countries. Variability in funding, especially in less economically developed countries, remains a critical challenge for maintaining and initiating international collaborations.
Entrepreneurship	Societific societies can help student and researchers enterpreneurship activities providing networking, funding contacts, and international visibility.
Rapid Technological Advancements	The pace of technological innovation, particularly in artificial intelligence (AI), biotechnology, and quantum computing, presents both an opportunity and a challenge for scientific collaboration.
Climate Change and Environmental Issues	As global environmental issues intensify, there is a growing need for scientific societies to take the lead in coordinating research on sustainable solutions.
Pandemic Preparedness	COVID-19 highlighted the necessity for preparedness for future pandemics, demanding more proactive roles from scientific societies in global health security.
Antiscience movement	Scientific societies can help reduce the growing antiscientific movement of public opinion, which has intensified and globalized in recent years, often linked to the spread of disinformation and conspiracy theories.
Consultancy to governments on political decisions related to science-based solutions	Scientific societies can provide valuable consultancy for decisions related to science and biotechnology, such as medical, pharmaceutical, agricultural, environmental, and aquaculture issues.
Collaborative challenges with major tech firms	Scientific societies face challenges in matching the resources and speed of innovation of major technology firms, as seen in instances like the Human Genome Project. Collaboration with such enterprises could harness complementary strengths.
Scientific awards	International science awards are vital tools for sharing knowledge and promoting science. They recognize outstanding achievements, encourage excellence in research, and enhance the visibility of significant scientific contributions on a global scale.

and risks. Consequently, EBTNA also emphasises thoroughly assessing potential ethical, moral, and practical risks associated with biotechnological advancements, such as concerns over cloning, animal experimentation, artificial womb technology, and biodiversity impacts [35–38] (https://www.ebtna.eu/). EBTNA has witnessed successful collaborations between its members, resulting in publications, grants, conferences organised, scientific missions, student exchanges and more. Many scientists in EBTNA can be recorded in giving examples where discussions at a café, in a restaurant, over a beer in a restaurant resulted not only in collegial friendships but also a bountiful creation of ideas and projects. Let's not forget the success the British have shown in creativity during their tea breaks!

Future challenges and opportunities for scientific societies

Although scientific societies can differ in scopes and goals, they have a huge impact on the careers of young and senior researchers, and they can support scientists in many ways. In the near future, the role of scientific societies in fostering international cooperation will face several emerging challenges and opportunities. Nevertheless, the resulting scientific cooperation will be pivotal for helping scientists and for

fostering peace and development [39,40]. Table 1 summarizes some of the key future challenges and opportunities for scientific societies.

Conclusion

Science and scientific societies play a critical role in promoting scientific cooperation and maintaining neutrality amidst global geopolitical conflicts. By fostering international collaborations, scientific societies not only advance scientific knowledge but also bridge different nations and cultures, leading to the improvement and development of societies. In this regard, the EBTNA scientific society exemplifies an important initiative in international scientific cooperation, bridging the world of biotechnology research and forstering international cooperation and activities.

Conflicts of Interest

All affiliations of the authors with private companies have been declared to make clear the position regarding the interests of these companies. The authors are affiliated with private companies for which there could be a possible conflict of interest. The authors of this article are reported to be patents inventors. The authors are members of scientific societies, some are members of the European Biotechnology Thematic Network Association (EBTNA).

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